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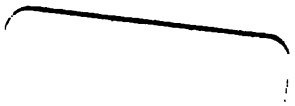

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WILLIAM J. TENNEY,

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STEPHEN P. LEEDS.

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## WILLIAM J. TENNEY.

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Mines, Mining Operations, Metallurgy, &c., &c.

VOL. VI.—JANUARY, 1856.—No. I.

## ART. I.—THE IRON MANUFACTURE OF GREAT BRITAIN—THEORETICALLY AND PRACTICALLY CONSIDERED.—By WM. TRURAN, C. E. No. 3.

[Continued from page 472.—Vol. V.]

### ERECTION OF THE BLAST FURNACE AND ITS APPENDAGES.

IN the erection of blast furnaces, care should be taken to provide a firm, unyielding foundation on which to rear the superstructure. The weight of the masonry, brickwork, iron gearing and plates is very great, but when to this is added the metal and the materials within the furnace, the weight becomes so great that a sound foundation is indispensable. Having brought the foundation to the level of the existing or intended furnace yard, the next step is the erection of the furnace.

Blast furnaces are built of various dimensions, ranging from 8 to 19 feet in their internal diameter, and 20 to 60 feet in height. By referring to the sections of blast furnaces in the plates appended to this work, the form and interior dimensions of a large number now in blast, may be ascertained. The one delineated in plate 2 is of the largest class.* The exterior dimensions of this furnace are 38 feet square at the base, diminishing, however, as we proceed upwards, 3 inches in the length of the side for every vertical foot, until it attains an elevation of 25 feet, when the square form ends with a moulded cap. Above this the form is circular, diminishing in diameter at a similar rate, and finishing at the top with a plain moulded cornice, as a support for the charging plates. The interior of this furnace is 18 feet in its greatest diameter, contracted to 10 feet in the throat. In building it is lined from the top of the tuyere arches with a double course of fire bricks, set in fire clay. The course next the interior is 14 inches long; between this and the outer course it is usual to leave a space of two or three inches all round, in order to allow of the expansion of the inner ring of brickwork without disturbing the face of the masonry on the outside. In some instances this space is tightly rammed with sand or fine clay, care being taken that a sufficiency of air

* See February No. of Mining Magazine.

holes are left during the operation. If the sand is stamped in solid, the steam generated during the working of the furnace is very likely to cause a rupture of the casing.

In order to give vent to any aqueous vapors or gases that may arise from the masonry during the drying and working of the furnace, air holes about 4 inches square, proceeding from the second course of 2 bricks outwards are left all around the furnace. Their greatest distance apart, vertically or horizontally, should not exceed 3 feet. They are a precaution against fracture, which should never be omitted; and if the furnace is to be blown in with very little previous drying, the distance between should be reduced at least one half.

In the base of the furnace, four arches will have been left; the back and sides are called "tuyere houses," the front is known as the "conder fall." Furnaces have been built with more than four arches, but we are not aware of any advantages being derived from increasing the number. The arches in the furnace under consideration are 9 feet span, where they join the interior; in some furnaces they are wider, but this width gives ample space for conducting the working operations. Proceeding outward, they increase in width to 12 feet, and the fall to 16 feet, a greater splay being given to the latter, for reasons which will appear hereafter. In one side of the fall, two cast metal brackets are built in the masonry for carrying the wrought iron crane employed in working the furnace.

The height of the arches, from the general foundation level to the springings, should be not less than 11 feet. Across each at the springing, it is usual to place, during the progress of the building, a massive cast iron mantle, about 13 feet long. These mantles are connected together by stout plates, having snugs to fit into corresponding recesses left in the mantles. The purpose of this circle of heavy castings, is to bind together and strengthen the lower part of the furnace, where it has been so much weakened by the insertion of the arches. The space between the mantles and the crown of the arch, a distance of about 4½ feet, is walled up with fire bricks.

Until within a comparatively recent period, the bottom was invariably formed of large blocks of coarse sandstone; great expense was incurred in quarrying, dressing, and setting the blocks in their respective stations. A single course about 2 feet high formed the bottom of the hearth.

In numerous furnaces, recently erected or repaired, the bottom is formed of fire brick, and the experience of nearly 20 years enables us to state that such bottoms work well, and are less costly than stone. Bricks of the common size were tried in the first bottoms, but in practice they were found to be too small. After the furnace had worked a few days, they floated on the metal in the fluided cinder, from whence they were withdrawn

by the workmen. It does not appear, however, that any permanent injury resulted from the displacement of these bricks, for the furnace has since remained in blast for a period of 12 years.

To prevent if possible this floating of the bricks, they are made larger, and of a peculiar form. The size of those which have stood extremely well, we have delineated in the accompanying plates. It will be seen that the contraction of the width at the middle, and the manufacture of corresponding half bricks, effectually locks every brick in its place. The bottom is composed of two depths of these, laid on a course of flat bricks, 6 inches thick. The total height or thickness of the bottom, therefore, is 4 feet.

At Scotch works where brick bottoms are used, the means employed to retain the bricks in their position are equally successful. The bricks are made of a length equal to the height of the bottom, but are moulded to such sections that, when placed on the foundation level, they form an inverted arch, as represented in the plate. This plan has the disadvantage of requiring several moulds, but it makes a sound bottom. The bricks being comparatively thin, can be insured of a perfectly homogeneous quality.

When finished, the surface of the bottom in one direction, from tuyere to tuyere, is perfectly level, but from the back tuyere to the front there is a fall of 3 inches in a length of 13 feet.

On the bottom the hearth is built. Hearths are of different forms and dimensions. Iron-masters who use stone for the bottoms employ the same material in building the hearths, while others, who have adopted the less expensive material, brick, find that it answers equally well for the hearth.

The form of hearth which we have found to answer best in practice, is that represented in pl. 3. It measures 8 feet in the greatest breadth, by 14 feet in length from the back tuyere to the damplate. At a height of 3½ feet from the bottom it is circular, and is continued of this form for 4½ feet, making a total of 8 feet. On each side, and in the back there is a small arch in the brickwork 2 feet 4 inches in the inside, widening to 5 feet at the outside, and reaching to the cast metal mantles, the lower edge of which forms the outer face of the arch. The one in front is about the same breadth, but the height does not exceed 3½ feet from the bottom at the outside, where it is smallest.

The boshes commence at the top of the hearth; their interior diameter increasing with their height until they meet the inner lining of brickwork, built during the erection of the furnace. They are usually constructed of fire brick, about 15 inches long, carefully laid in fire clay. Considerable diversity of opinion exists respecting the best angle at which they should incline outwards from the hearth. In practice we have generally adopted an angle of 70° from the horizontal, as being the most suitable, and the results therefrom warrant us in saying that this angle

may be adopted in all furnaces for smelting argillaceous or carbonaceous ores. But when other ores are to be smelted, the character of the ore and fuel will have an important bearing on the form of the boshes as well as in the hearth and furnace generally. We purpose examining the relation which these should bear to each other in another section.

The form of the furnace, from the boshes to the throat, is also a matter on which a difference of opinion exists amongst ironmasters. Formerly, it was invariably that of a truncated cone, as is seen in the majority of the blast furnace sections; but of late years numerous furnaces have been otherwise built. In Scotland, the body of the furnace frequently is carried up cylindrical, or nearly so, for a considerable height, terminating with the usual truncated cone to the mouth. The advantages which are supposed to attend the different forms we shall defer the consideration of, to a more advanced portion of the work.

To complete the furnace a chimney, or, as it is termed in South Wales, "tunnel-head," is erected above the charging plates. This tunnel-head is generally of a diameter larger than the mouth of the furnace, and is carried up to a height of 10 or 12 feet. For filling the furnace one or more openings are left in it, through which the furnace is charged. The number of filling places varies with the size of the throat. Where there is more than one, each opening is fitted with a metal door, to protect the workmen from the draught. The tunnel-head is built of brick, strengthened by stout cast iron rings at bottom and top, and cast iron frames to the charging places. They are further strengthened with 4 or 5 stout iron hoops, having tightening screws, which effectually secures the brickwork from being fractured by the great heat evolved from the ignited materials in the throat of the furnace.

In the erection of walled blast furnaces, the exterior line of which deviates from the vertical, we have found it advisable to work the stones with a square front, and set the courses with a dip from the level towards the centre of the furnace, corresponding to the batter in front. Besides the evident saving in labor and material, the work is considerably stronger and the face less liable to breakage from expansion. In the interior also, we advise the setting of the bricks or stones forming the hearth, and the bricks forming the boshes in a similar manner. By so doing, the interior cavity from top to bottom may be worked without steps, and with little waste of material. With the boshes, this mode of setting should always be followed. We have observed furnaces in England and Scotland, wherein the necessary angle has been given to the boshes by stepping back each course the required distance, and afterwards plastering over the interstices with fire clay, to produce the desired evenness. Were the other plan followed—the bed of the courses sloped downwards as they recede from the face of the work, the end of the bricks forms the

correct angle of inclination without dressing or subsequent plastering.

The binding employed to prevent the work from opening, requires to be very strong and easy of renewal. For this purpose they should be on the outside, or otherwise so placed that they may be changed in a few hours. The furnace delineated in plate 2, is strongly bound, and has stood remarkably well. The lower portions are bound together with cast iron angle pieces and wrought tension rods 2¼ inches square. The circular portion is bound throughout with wrought iron hoops 3½ by ½ inch, placed 6 inches apart, and maintained at this distance by vertical rods of the same dimensions.

In Scotland the outlay on the materials for binding certain furnaces has been very large. At the Muirkirk works, a furnace is cased in malleable iron plates from top to bottom. Great strength is thus obtained, but the expense is such as must preclude its general adoption.

To expedite the operation of drying, 2 small arches are left in each of the pillars of masonry at the base, of a size sufficient to contain a fire 3 feet by 1½ feet. From the crown a flue, about 10 inches square, is carried up through the masonry to the top of the furnace. With this flue the whole, or nearly so, of the holes left in the masonry, for ventilation should communicate. Where this is done, a rapid, yet perfect drying of the masonry, without any of the usual unsightly fissures, may be successfully accomplished.

The drying of the furnace previous to blowing in, requires time and fuel commensurate with its dimensions. If it is large, two months may be well spent in the operation, and a consumption of 70 tons of coal will not be large. The interior brickwork will be best dried by a temporary furnace in the cinder-fall, communicating directly with the interior. While this furnace is in operation, the tuyeres are temporarily bricked up to prevent the ingress of cold air, and the mouth is partially covered over to diminish the draught and retain the heat within the interior.

After drying the temporary furnace in front is removed, the brick stopping in the tuyeres taken down, and preparations may be made for blowing in. The tuyeres are built up with brickwork to a height of two feet on each side, and 2 feet 3 inches in the back. In some furnaces this height is made up with a hollow cast iron block, through which water is allowed to circulate while the furnace is in blast. Above this brickwork the cast or wrought iron tuyeres are placed, with their points flush with the wall of the hearth; and the remainder of the space filled up with brickwork, 18 to 24 inches thick.

In front, in the cinder-fall, a cast metal damplate is bolted to two wrought iron bolts built in the brickwork of the hearth. This plate measures about 6 feet long, 3 feet high, and 3 inches

thick. Near the centre an opening, 9 inches wide by 20 high, is left for tapping, the bottom being flush with the bottom of the hearth, and one side parallel with the brickwork inside. In the upper edge, a notch 8 inches wide, is left for the cinders to flow through. The height from the brickwork of the bottom to the under side of this notch is an important measurement: in this instance it is 24 inches. To retard the wearing or burning away of the metal at the underside of the notch the thickness of the metal is there doubled. On the outer side, close to the tapping hole, a vertical flanch is cast to secure one end of a cast plate set on edge, to retain the flowing cinders on one side of the fall.

At the distance of 16 inches above the notch, and 26 inches inside the damplate, it is usual to fix a tymplate within a recess, provided for that purpose in the brickwork. The tymp is generally 2 inches thick and 3 feet high, with a short flanch on the under side as a protection to the brickwork over the fall. Tymps having a small water pipe laid in a serpentine form in the cast metal are in use at several furnaces, where a high local heat prevails. At other works, however, we find the furnaces working with an unprotected breastwork of brick.

The other preparations in the cinder-fall principally consist in hanging a wrought iron crane; fixing a cast iron plate, having its upper edge serrated, to facilitate the removal of large masses of cinder; laying down a cast metal trough, about 6 feet long, to convey the fluid metal from the tapping-hole to the casting-bed or refinery; and fixing two troughs on the cinder-bed for guiding the fluid cinder into the tubs. Immediately before filling, the portion of the damplate exposed to the fluid metal is protected by a stone or mass of brickwork, to a level with the cinder-notch.

The conveyance of the blast to the furnace is accomplished in various ways—by leather bags, cast iron pipes, wrought iron fixed, and wrought telescope pipes.

For cold blast furnaces, this last is probably the most durable, and attended with the least waste of blast. It consists of a thin wrought iron pipe, generally 10 inches diameter and 6 feet long, having riveted within one end a light cast iron cylinder, bored and turned, and on the other a cast iron flanch. The large end of the sliding telescopic pipe is furnished with a metal ring, turned to fit the interior of the cylinder, and has a small groove to receive packing. The length of the sliding pipe should equal that of the fixed; the diameter at the small end being for the above size cylinder 5 inches, and at the large end 8 inches. To prevent its entire withdrawal, the interior of the cast iron cylinder is provided at the outer end with a small hollow flanch, against which the piston is ground air tight to prevent leakage. The loose wrought iron nozzles, placed on the small end of the sliding pipe, should be about 2 feet long, and of a diameter proportioned to the volume and density of blast to be delivered. To the cast

flanch, on the rear of the wrought cylindrical pipe, there is attached an universal joint, consisting of a cup and ball, accurately ground to each other, and connected by two wrought eye bolts. This joint allows of any lateral or vertical movement in the pipes that may be rendered necessary, through changes in the position of the tuyere. Connected with this joint is the valve for regulating the admission of the blast. A plain iron slide, planed and ground air tight, with a rod working through a stuffing box, is the simplest and most effective. Bolted to the rear of the stop-valve-box is an elbow pipe, 10 inches bore, with the curve upwards, joining other pipes from the blowing apparatus. In the majority of works, it is usual to have this elbow turning down, and connected with larger pipes laid below the surface. However neat such an arrangement may appear, in practice it is attended with many disadvantages. With a sudden stoppage of the blowing apparatus, the cinders not unfrequently flow back through the pipes into the subterraneous mains, thereby causing expense and delay; and in the event of leakage of blast from the joints, the difficulty of stopping it is greatly increased.

In the back of the elbow an orifice, about one inch in diameter, is drilled in a line with the centre of the tuyere, and fitted with a metal stopper. Through this orifice a small iron rod can be introduced to clean the tuyere when fouling; and when a heated blast is used it is convenient for trying the temperature.

The pipes used for hot blast furnaces differ from the preceding in the absence of the wrought telescope apparatus. Cast metal pipes, diminishing in size as they recede from the cup and ball joint, with wrought muzzles similar to those with a cold blast, are in general use. At some of the Welsh cupola furnaces, the limited room for the pipes has caused a lighter and more compact arrangement to be adopted, as seen in the plate of details.

Leather bags are employed at some works with a cold blast; and where the supply of blast is not dependent on a single engine or apparatus, and careful workmen are employed, the connection lasts a considerable time. This mode of conveying the blast is in use at all the furnaces in the Plymouth and Duffryn works.

The top of the furnace around the tunnel head is floored with cast iron plates, $\frac{3}{4}$ to an inch thick, and where the materials are wheeled into the furnace from the same level, a continuation of the plates is carried out to the standing place of the fuel, ore, and flux, forming a level barrow-road for the fillers to wheel the charges. In front of each stocking place, it is desirable to have, on a level with the floor, a lock-up platform weighing machine, weighted according to the burden on the furnace. The usual arrangement is to have two, sometimes three, beam-weighing machines at the bridge plates, where the quantities are adjusted, recourse being had to a small supplementary stock for supplying deficiencies. With platform machines, conveniently fixed at the

stocking places, the barrow rests on the machine whilst being filled; the exact quantity is determined on the spot; greater accuracy is obtained, and much labor economized.

### APPARATUS FOR LIFTING THE MATERIALS.

The apparatus for raising the materials to the level of the charging plates, is wrought by steam, water, or pneumatic power. In the South Wales district, the iron-masters have taken advantage of the generally mountainous character of the locality to erect the furnaces on hill sides, having back ground on a level with the furnace top, over which the materials are wheeled direct into the furnace, and, with the exception of a small number of furnaces, it has not been necessary to erect machinery for the purpose. But in the more level districts of England and Scotland machinery is very generally employed in elevating the materials.

One of the most common methods of raising the loaded barrows is the inclined plane and stationary steam power. An inclined plane is constructed to the furnace top, at an angle of about 25°, with two tracks of rails; each track is traversed by a single platform carriage, which is drawn up and let down by a chain from the engine drum acting over a pulley at top. When at the bottom of the plane, the platform is on a level with the adjacent ground; the barrows are wheeled on, and the carriage drawn to the top, where it is brought to a standstill with the platform, on a level with the staging around the furnace. The contents of the barrows having been discharged into the furnace, they are replaced on the platform, the carriage is lowered, and the opposite carriage, with its loaded barrows drawn up. By employing two carriages, the weight of the descending acts as a counterpoise to the ascending, consequently the load to be lifted at each time is simply the weight of the material in the barrows. To work an incline plane which supplies 4 blast furnaces requires an engine of 10 horse power.

From the great wear and tear of the carriages, pullies, and chains, with the constant liability to derangement, added to the space which they occupy, an inclined plane is an expensive method of raising the materials. In the event of the chain breaking —not an unfrequent occurrence—considerable delay occurs in the supply of materials to the furnace, occasioning a loss independent of repairs and renewal. Hence, although in use at a number of old furnaces, this mode of lifting is rarely adopted in new erections, and is likely to be altogether superseded by simple and more efficient machinery.

The water-balance lift employed at some furnaces, is a cheap method of raising the materials. It consists of two cylindrical or rectangular sheet iron buckets or cisterns, suspended from a strong chain, which works in a groved brake wheel, revolving in stand-

ards at a height of 10 or 11 feet above the staging around the furnace top. Each bucket is provided with a platform to receive the barrow, and has a valve at the bottom for discharging the water; it is guided in its ascent and descent by guide rods, bolted to framing at top and bottom. A pipe supplied with water (generally by a plunger pump attached to the blowing engine), and fitted with a box containing two spindle valves, one for each bucket, complete the essentials of the apparatus.

The operation of lifting, premising that both buckets are empty, one at the top, the other at the bottom, is performed by letting into the upper bucket, supporting the empty barrow, a quantity of water, rather more than sufficient to counterbalance the weight of the load in the barrow on the lower bucket. On lifting the friction brake from off the wheel, the greater weight of the descending bucket draws the opposite one with its load to the top, where the contents of the barrow is discharged into the furnace. To repeat the operation the empty barrow is replaced in the upper bucket, and the valve in the lower opened to allow of the water escaping; a loaded barrow is wheeled on it, and water admitted to the upper bucket till it begins to descend. The velocity of descent is regulated by the friction brake, which should be sufficiently powerful to stop the buckets at any desired spot, and to control the speed, so that on their arrival at top and bottom they may be brought to a standstill without that violent concussion common with these machines. In order that the brake may accomplish this, the buckets should exactly balance each other in weight, and a chain be connected from their bottoms of a similar weight to the one employed in lifting. Unless such balance chain be employed the bucket will descend with an accelerated velocity, and strike heavily against the bottom frame.

Several modifications of the water balance lift may be seen in operation; one consists of a single bucket with a platform at the other end of the chain. Water is admitted to the bucket until it overbalances the load on the platform, which is then drawn up and wheeled off. The descent is caused by the superior weight of the platform and empty barrow over that of the empty bucket, controlled by the brake. In another modification of this apparatus, the descent of the water bucket and the lift of the barrow platform are not equal; the bucket probably descends a less height than that which the materials have to be lifted. Separate chain drums on the same axle are employed; the diameters in the same ratio as the lift and descent.

The dimensions of a water balance lift will depend on the size of the barrows, and the number of furnaces it is to supply. At the Dowlais works four furnaces have each a water balance lift. But one apparatus will suffice for three or four furnaces, premising that the materials to be lifted daily do not exceed 500 tons. The greatest load to be sent up in the barrows will deter-

mine the size of the buckets. With barrows containing 15 cwts. —a large size—wrought buckets 5 feet square and 2 feet deep will not be too large, and if of any other form they should be capable of containing 50 cubic feet of water. Inch chains are used for lifting and balancing; and the pipes for the conveyance and delivery of the water are of 8 inches bore.

Although employed at several new furnaces, an inexpensive mode of lifting the materials, especially where a sufficient fall of water can be obtained without having recourse to pumps, the liability to accident from breakage of the chains must ever prevent the water balance apparatus from being extensively adopted. To diminish the risk of the chains breaking, two and sometimes three have been combined together, each of sufficient strength to carry the load, but the use of these chains was attended with a serious disadvantage. Where a single chain is employed, it works tightly in a triangular-shaped grove in the brake wheel, which has a controlling power; but with flat chains, owing to the plain cylindrical form of the sheave, on appplying the friction brake to check the velocity, the chain slips, and the brake has no controlling action whatever.

At some furnaces the steam power has been applied to the hoisting of the materials by a vertical lift; two platforms being connected by chains to two opposite sides of a drum keyed on the engine shaft. Guides for steadying the platforms and catches at the top to retain them at the required elevation, similar to those in coal pits worked by steam power, are also necessary in vertical lifts. But the risk from accident is equally great, if not greater than in either of the foregoing machines, and to this cause we ascribe the comparative rarity of vertical lifts, worked by steam power.

The employment of pneumatic lifts is of very recent date, but they are now in use in several Scotch, English and Welsh works. Superior to either of those described in freedom from accident, quietness of motion, and facility of management, the pneumatic lift supplies a desideratum of long standing.

The pneumatic lift for raising the materials the entire height consists of a well in the rear of the furnace, about 7 feet diameter, and 8 to 10 feet deeper than the height of the lift, rendered water tight by brick or metal casing. A wrought iron cylindrical tube, open at the lower, but closed at the upper end, works up and down in this well. On the top of the tube a suitable platform is fixed, to carry the loaded barrows; from the platform four chains proceed over pullies revolving in bearings at the top of the framework, having attached to their extremities weights nearly sufficient to balance the tube and platform. Perpendicular timbers act as guides to the platform, which is furnished with four angular pullies as guide rollers. A pipe fitted with a stop valve is brought from the blast main, carried down one side of

the well to the bottom, turned up in the centre, and brought to within 4 or 5 feet of the surface. The well is filled with water to within 5 or 6 feet of the top, having the wrought tube open at the lower end standing in it, and surrounding the centre upright blast pipe.

Loaded barrows having been wheeled on the platform, and the stop valve in the blast pipe opened, the blast presses against the top of the inverted tube with a force proportional to its density, and the superficial area of the end of the tube. The density of the blast being fixed, the requisite lifting power is obtained by proportioning the diameter of the tube to the load. If this has been done, the tube emerges from the well, carrying the loaded barrows to the top. On arriving there the blast valve is partially closed, and the tube maintained at the same level by the elasticity of the blast within. The loaded barrows having been wheeled off, and their contents discharged into the furnace, are replaced on the platform for a descent. This is accomplished by shutting the inlet blast pipe at the bottom by means of a vertical rod carried up alongside the framing and raising the escape valve in the top of the tube to allow the confined air to gradually escape into the atmosphere; the pressure being removed from underneath, it descends with a greater or less velocity, depending entirely on the area of the escape valve.

The recommendation possessed by the pneumatic lift over all others, consists in the perfect control which the workmen have over its movements. In ascending, the velocity is easily controlled, the quantity of blast admitted being regulated to the requirements of the load and velocity; the latter may be considerable, yet, by partially shutting the inlet valve before arriving at the top, the weight in motion, amounting to 20 or 25 tons, may be brought to a standstill without any perceptible concussion; and whilst this valve is partially open the pressure of the blast will maintain the platform against the top plates unsupported by catches. The control over the motion in descending is equally perfect. When ready for the descent the inlet valve is entirely shut, and the escape or discharge valve in the closed end of the tube opened. If this valve were of very large dimensions the apparatus would descend with great rapidity; but with the small valves employed, the removal of the pressure is so gradual that the greatest possible velocity of descent is unaccompanied with injury.

At the Corbyn's Hall new furnaces, one pneumatic lift, with a tube about 5½ feet in diameter, suffices for 4 furnaces. The inlet pipe is equal to 7 inches bore, and a pressure of blast of 2¼ lbs. to the square inch is employed. This multiplied by the area of the cylindrical tube in square inches, gives a lifting power of 7,981 lbs. The load of materials lifted each time, including barrows and workmen, averages 5,040 lbs. leaving a surplus power

of 2,941 lbs. to cover the unbalanced weight of the tube and all contingencies. With a denser blast, such as is used at some Welsh works, the same load could be raised by a tube of one half that area; but in practice it is preferable to use a full size tube, and augment the number or weight of the barrows in proportion to the increased power.

The working cost of lifting the materials with the pneumatic lift is equally great with the others; but the cost of repairs and renewals is unquestionably much less. With an apparatus of the foregoing dimensions, lifting 50 feet vertical, the consumption of blast is about 1,200 cubic feet for every 30 cwts. lifted that height. Allowing that it requires 8 tons of material to each ton of pig metal made, to raise this weight will require an expenditure of 6,400 cubic feet of blast, at a pressure of $2\frac{1}{2}$ lbs. to the square inch. The cost of compressing atmospheric air to this density will be affected by local circumstances, but at several Welsh works, the cost of compressing 100,000 cubic feet to that density, including all expenses incidental thereto, will not exceed 3d. This is equal to three sixteenths of a penny per ton, and if to this there be added another three sixteenths, as the cost of erecting and maintaining the apparatus, we have a total cost of $\frac{3}{4}$ of a penny per ton, on the pig iron made, as the cost of lifting the materials 50 feet high.

### HEATING APPARATUS.

The use of heated air for the furnaces having been extensively adopted in the manufacture of iron, a description of the apparatus employed will not be out of place. We may mention, however, that the great saving of fuel and increased make of iron, which the advocates of the hot air system strenuously maintain as invariably following its application, is almost entirely due to other causes. We shall enter more fully into this common mistake regarding the hot blast in our description of the blast furnace operations, and will confine ourselves in this place to a description of some apparatuses in which the blast was raised to a high temperature.

In furnaces recently erected, generally sufficient space is left on each side and the back to erect a separate stove to each tuyere; but in many old established works using the hot blast, owing to the limited room between the furnaces, a single stove, placed at the back or at a distance from the furnace, suffices to heat the blast for all the tuyeres at a furnace. The plan of single stoves possesses many advantages over the other, and is adopted wherever practicable. The size of the stove should bear some relation to the quantity of blast to be heated, but in practice we do not find any rule observed. At one works, a stove employed to heat for one tuyere will be as large as a stove at other works, heating for an entire furnace.

The plan of stove very generally used, and one which we have found capable of maintaining a high temperature, is delineated in the plate of hot blast stoves. It consists of two horizontal pipes, 14 inches bore, and 2 inches thickness of metal, having cast on their upper side a number of sockets to receive the same number of small pipes, of a horse-shoe figure, which stand in a vertical position, one leg in each horizontal pipe, thereby forming a communication between them. Below and between the horizontal pipes a suitable fire grate is constructed, and furnished with a close fitting door. The exterior of the frame work of pipes is surrounded with walling, arched at top to the curve of the vertical pipes, and lined throughout with fire brick. At one end a flue is constructed for carrying the smoke to a chimney 8 or 9 feet higher than the roof, having a damper to regulate the draught. To prevent the heated products of combustion passing direct to this flue, instead of impinging on the curve pipes, the communication to it is through a number of small apertures, distributed over the rear end of the interior. And as a protection against the direct action of the fire, with which they otherwise would be in close contact, the horizontal pipes are cased with brick work, the length of the fire place. Vertical binders resting in cast iron sockets, built in the walling at the bottom, and connected at top by wrought iron bolts, are necessary to enable the walls to withstand the great heat, and the thrust of the arched roof.

Blast is admitted to one of the horizontal pipes at the end farthest from the fire, from whence it passes up through the vertical pipes, and down into the opposite horizontal pipe, one or both ends of which are closed. During its passage through the vertical pipes, the blast will have absorbed sufficient caloric from the heated pipes to raise its temperature 600 or 800°. We have here supposed that the cold blast is admitted at one of the large pipes, and the hot air coming from the vertical pipes is immediately delivered at the farthest end of the opposite pipe, after passing once through the vertical range—the plan adopted at several works: but another, and perhaps superior arrangement, consists in coursing the air through a portion only of the vertical range at once. This is effected by fixing stop plates in the horizontal pipes, thereby causing the blast to make a more circuitous course. If the stove consists of 26 vertical pipes, and the first stop is between the 5th and 6th pipes, the blast will pass through 5 pipes to the opposite side; then, if the next stop is between the 11th and 12th, it will return through 6; again, by disposing the stops back through 7, returning to the same pipe through 8, after coursing a distance of between 90 and 100 feet.

The increase in the number of pipes for each course, as the blast approaches the terminus, compensates for the greater volume of the hot air in these courses. The blast enters at about 50°, but

leaves with a temperature of about 600°. With this accession of temperature, its volume is nearly doubled. Hence, the area of the pipes must be increased in a similar ratio, or the velocity will be very great. Since an increase in the velocity is attended with a corresponding increase of friction, and, consequent thereon, a diminution of useful effect from a given power employed, the utility of the increased area given to the finishing courses is generally admitted.

Although sockets cast fast on the body of the horizontal pipe, to receive the feet of the vertical pipes, is the usual mode of connecting the pipes, a much superior plan is to cast spickets about 6 inches long, of a size and bore similar to the vertical pipe. Around this spicket a loose socket piece about 12 inches long is clayed and cemented; into the projecting part the foot of the vertical pipe is subsequently fixed. This plan of joining the pipes is the most expensive at first, but in the event of a defective or burnt pipe requiring to be changed—a matter of very frequent occurrence in all heating apparatuses—the time required for the operation is very much less than if fast sockets are used. The separation is effected by breaking the loose socket, and employing others with the new pipe.

At the Dowlais works, each of the new blast furnaces, four in number, is fitted with three hot air stoves, one to each tuyere. The horizontal pipes are 14 inches internal, and 18 inches external diameter. Each pipe has on its upper surface 26 cast sockets, 6 inches deep, and 8¼ inches between centres. These sockets receive the ends of the vertical pipes, which measure over the foot and crown, 8 feet 3½ inches, and over the legs, 5 feet 0½ inch; the sectional area of the interior, which is of V shape as shown in the plate, is 18 inches. The fire places, 2 to each stove, measure 2 feet 3 inches wide by 6 feet 11 inches long.

The superficial area of the pipe surface exposed to the action of the fire in each stove is 1,001 square feet; this is heated by two grates of a total area of 31 feet. The quantity of blast entering the inlet pipe of each stove, at an average pressure of 3 lbs. to the square inch, is 1,800 cubic feet per minute. Hence, in these stoves, there is 555 square feet of pipe, and 17 square feet of grate surface for each 1,000 feet of blast, heated to a temperature of 600° in a minute.

At three other furnaces, in the same works, the stoves are considerably smaller. The total surface exposed by the vertical pipes in each stove is 503 superficial feet; the grate surface 15½ feet, and quantity of cold air entering the stove, at a pressure of 2¾ lbs. to the square inch, is 1,860 cubic feet per minute. Hence, for each 1,000 feet of blast entering the stove per minute, there is 270 feet of heating, and 8⅓ feet of grate surface.

In the small stoves it is difficult to maintain a constant temperature sufficient to melt lead, but in the large stoves this tem-

perature is maintained with great regularity. We, therefore, may conclude that these stoves represent the maximum and minimum proportions, which the pipe and grate surface should bear to a given quantity of blast to be heated to about 600° in a stated time.

The vertical pipes we have described, have their sides parallel with each other, but they are occasionally constructed with a greater spread at foot than crown, as represented in the plate. The sectional construction is also varied from that given—from circular to the V shape—a flat oblong and an elliptical form, with the view of obtaining the greatest heating surface in the least space.

The varieties of heating stoves employed, are very numerous indeed. Of late years a considerable number have been erected, with the pipes disposed in a spiral form, as delineated in the plate; but the advantages which it offers over the more common form of stove are not very apparent.

(To be Continued.)

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## Art. II.—ANALYSES OF GAS COAL.*

Light carburetted hydrogen ($C_2H_4$) contains 75.4 carbon to 24.6 hydrogen; olefiant gas ($C_4H_4$) 86 carbon to 12 hydrogen. The proportions of the elements in the latter gas render it well adapted for illuminating purposes, could it be procured at a sufficiently cheap price. This, however, is not the case; and we are obliged to be content, from motives of economy, with a mixture of gases, which contains so much olefiant gas that it far exceeds light carburetted hydrogen in illuminating power, and is produced by the decomposition of certain substances of organic origin. When these organic substances are exposed to a certain temperature in closed vessels, the following process results:—A carbonaceous residue (coke) remains in the vessel, while certain volatile products escape, a portion of which are condensed on cooling into tar and an aqueous fluid, the remainder being a mixture of gases, with a considerable proportion of the volatile vapors of the different compounds, the greater part of which have been condensed with the tar. The accompanying scheme will give at one view the nature of the products resulting from this process.

The researches of Sell, Blanchett, Runge, Kidd, Reichenbach, Hoffmann, Anderson, Mansfield, and others, upon coal-tar, have led to the knowledge of a number of oily volatile products of very different chemical constitution, most of which are compounds of carbon with hydrogen. To these we shall revert particularly in

* Chemical Technology, New York, H. Bailliere.

## PRODUCTS OF THE DISTILLATION OF COAL.

**Fixed residue:**—Coke containing carbon and the ash of the coal.

**Volatile Matters.**

- **Liquids, condensed and collected in tar-cistern**
  - **Coal-tar gives on redistillation with water or steam**
    - **Distilled tar; which affords on further distillation**
      - **Pitch; distilled in ovens, affords**
        - Pitch coke.
        - Coke oil.
      - **Dead, or pitch oil, consisting of**
        - Naphthaline, paranaphthaline, and oily hydrocarbons boiling at a high temperature, creosote, aniline, leucoline.
    - **Crude coal-tar naphtha, which consists of . . . . .**
      - Acids—Rosolic, carbolic, brunolic, creosote,
      - Basis of the pyrol, picoline, aniline, leucoline, methylamine, ethylamine, and other series.
      - Neutral—Alliole, benzole, toluole, cumole, cymole, and other carbohydrogens; naphthaline, hydrate of phenyle (Laurent).
  - **Ammoniacal liquor containing**
    - Water, hydrosulphate of ammonia, carbonate of ammonia, muriate of ammonia, acetate of ammonia, hydrocyanate of ammonia, sulphite of ammonia, gallate of ammonia.
- **Gases and vapors**
  - **Gases and vapors separated in lime-purifyer . . . . . .**
    - Carbonic acid.
    - Sulphuretted hydrogen.
    - Hydrocyanic acid.
    - Ammonia.
  - **Gases and vapors separated sometimes by additional chemical agents**
    - Ammonia.
    - Hydrocyanic acid.
  - **Gases and vapors conducted to gas-holder . . . . . .**
    - Olefiant gas.
    - Vapors of hydrocarbons.
    - Light carburetted hydrogen.
    - Hydrogen.
    - Carbonic oxide.
    - Very small quantities of
      - Nitrogen.
      - Vapor of bisulphuret of carbon.
      - Ammonia.

treating of the secondary products of the gas manufacture; and for the present it is only necessary to remark that they contain a very large proportion of carbon, ranging from 90 to 94 per cent., and in burning, deposit it in still greater quantity than olefiant gas. It is obvious, therefore, why a portion of the vapors of these substances remaining in the gas should so much enhance its value. Omitting all notice, for the present, of the noxious and useless gases which are separated in the process of purification, we have, therefore, to consider illuminating gas, not as a definite compound, nor as light carburetted hydrogen or olefiant gas, but as a mechanical mixture of several gases and vapors, some of which are little if at all luminous, while to the others, including olefiant gas and the carbo-hydrogens which possess similar properties, the mixture is indebted for its illuminating power. The compounds of carbon and hydrogen are remarkable for uniting in the same proportions by weight to form a series of solids, liquids, and gases, possessing very different physical properties, according to the amount of contraction of volume which their elements have undergone in the moment of combination. Thus, among solids, naphthaline and paranaphthaline both contain carbon and hydrogen in the relative proportions of $C_5 H_4$, but the densities of their vapors, their boiling points, and relation to other similar bodies, render it apparent that these numbers must be multiplied by 4 in the first, and by 6 in the second, so that they are represented by $C_{20} H_8$ and $C_{30} H_{12}$ respectively.

Among the liquid hydrocarbons, a great number possess very dissimilar physical properties, and yet exhibit the same percentage composition; thus, the composition of the oils of turpentine, of lemons, roses, juniper, some of the naphthas from tar, and many others, are represented by the crude formula $C_5 H_4$; or, indeed, the formula $C_{20} H_{16}$ appears equally applicable to the whole. The gas obtained from the distillation of oil has the same composition in 100 parts as olefiant gas, but its density indicates that it contains double the number of atoms; while the one is represented by $C_4 H_4$, the other is assigned the formula $C_8 H_8$. Coal, wood, fats, turf, oils, resin and tar, asphaltum, soap-water, and the refuse of animal bodies, have all been proposed for the manufacture of illuminating gas. Of the adaptation of some of these to that purpose we have already spoken: the locality exerts considerable influence upon the relative values of others, and as the different nature of these substances demands a different mode of treatment in preparing the gas, each must be separately discussed.

*Gas Coal.*—The nature of the coal which is submitted to distillation in the manufacture of gas exerts such a decided influence upon both the quantity and quality of the gaseous product, that notwithstanding the numerous and extensive series of coal analyses already contained in former sheets of this volume, we consider it absolutely indispensable to add others made especially with refer-

ence to the coal used for gas making; and for these we are principally indebted to the author of the "Chemistry of Gas Lighting," in the journal devoted to that subject, and to the recent work of Mr. Hughes on "Gas Works."

The following table embraces information upon nearly all the varieties of coal employed in the united kingdom for the manufacture of gas, stating their specific gravities, the amounts of volatile matter, coke, and ash yielded in the retort, with the quantities of sulphur contained respectively in the coal, volatile matter, and coke; and nature of the ash.

| | Name of Coal. | Spec. Grav. | Volatile Matters. | Coke. | Ash. | Nature of Ash. | Sulphur in Coal. | Sulphur in Coke. | Sulphur in Volatile Matters. |
|---|---|---|---|---|---|---|---|---|---|
| Pure Cannel Coals. | Boghead | 1·221 | 68·4 | 31·6 | 22.8 | Silicate of alumina | 0·53 | 0·08 | 0·45 |
| | Kirkness | 1·208 | 60· | 40· | 13·5 | Silicate of alumina and oxide of iron | 1·4 | 0·58 | 0·82 |
| | Capeldrae | 1·2275 | 54·5 | 45·5 | 10·5 | Silicate of alumina | 0·65 | 0·20 | 0·45 |
| | Old Wemyss | 1·3256 | 52·5 | 47·5 | 15·1 | Oxide of iron and silicate of alumina | 1·30 | 0·60 | 0·70 |
| | Lesmahago | 1·222 | 49·6 | 50·4 | 9·1 | Silicate of alumina and oxide of iron | 2·25 | 1·14 | 1·09 |
| | Knightswood | — | 48·5 | 51·5 | 2·4 | Oxide of iron and silicate of lime, with alumina | 1·1 | 0·61 | 0·49 |
| | Armiston | 1·1967 | 45·5 | 54·5 | 4·18 | Silicate of lime, alumina, and oxide of iron | 1·70 | 0·95 | 0·75 |
| | Wigan | 1·271 | 37·0 | 63·0 | 3·0 | Oxide of iron and silicate of alumina | 1·25 | 0·60 | 0·65 |
| | Ramsay's Newcastle | 1·290 | 36·8 | 63·2 | 6·6 | Oxide of iron and silicate of lime, with alumina | 1·75 | 0·94 | 0·81 |

| Name of Coal. | Spec. Grav. | Volatile Matters. | Coke. | Ash. | Ash in Coke pr. ct. | Sulphur in Coal. | Sulphur in Coke. | Sulphur in Volatile Matters. |
|---|---|---|---|---|---|---|---|---|
| Lochgelly Cannel | 1·320 | 33·5 | 66·5 | 13·1 | 29·7 | 0·75 | 0·25 | 0·5 |
| New Brunswick Cannel (Asphaltum) | 1·098 | 66·3 | 33·7 | 0·6 | 1·78 | 0·7 | 0·0 | 0·7 |
| Pelton Main | 1·270 | 28·4 | 71·6 | 1·41 | 1·96 | 1·1 | 0·62 | 0·48 |
| Pelton Main Cannel | 1·320 | 31·5 | 68·5 | 9·4 | 13·7 | 0·95 | 0·49 | 0·46 |
| Leverson's Wallsend | 1·278 | 34 9 | 65·1 | 4 9 | 7·52 | 1·3 | 0·65 | 0·65 |
| Leverson's Wallsend Cannel | 1·320 | 30·8 | 69·2 | 9 85 | 13·67 | 1·0 | 0·5 | 0·5 |
| Washington | 1·260 | 31·25 | 68 75 | 2·2 | 3·2 | 1·3 | 0·67 | 0·63 |
| Washington Cannel | 1·326 | 27·4 | 72·6 | 9·37 | 12·9 | 1·1 | 0·56 | 0·55 |
| Pelaw Main | 1·271 | 30·3 | 69·7 | 2·60 | 3·7 | 1·2 | 0·7 | 0·5 |
| Urpeth | 1·271 | 28·7 | 71·3 | 1 85 | 1·89 | 1·0 | 0·6 | 0·4 |
| New Pelton | 1·265 | 30·2 | 69·8 | 1·71 | 2·5 | 1·1 | 0·56 | 0·54 |
| Dean's Primrose | 1·261 | 29·25 | 70·75 | 2·4 | 3·4 | 1·4 | 0·71 | 0·69 |
| Stavely (Derbyshire) | 1·275 | 40·9 | 59·1 | 2·7 | 4·57 | 1·2 | 0·8 | 0·4 |
| Elsecar Low Pit (Yorkshire) | 1·258 | 37·0 | 63·0 | 1·1 | 1·74 | 1·2 | 0·63 | 0·57 |
| Grigleston Cliff, soft (Yorkshire) | 1·255 | 35·6 | 64·4 | 1·6 | 2·48 | 1·4 | 0·75 | 0·65 |
| Silkston, No. 1 (Yorkshire) | 1·26 | 34·1 | 65·9 | 2·78 | 4·2 | 1·3 | 0·8 | 0·5 |
| " No. 2 " | 1·259 | 38·0 | 62·0 | 2·55 | 4·1 | 1·1 | 0·6 | 0·5 |
| " No. 3 " | 1·262 | 35·2 | 64·8 | 2·8 | 4·3 | 1·45 | 0·75 | 0·7 |
| Arley Main (Lancashire) | 1·270 | 33·7 | 66·3 | 3·6 | 4·8 | 1·2 | 0·6 | 0·6 |
| Heathern (Staffordshire) | 1·280 | 42·9 | 57·1 | 1·75 | 3·0 | 1·5 | 0·7 | 0·8 |
| Coal-pit Heath (Gloucestershire | 1·370 | 30·1 | 69·9 | 5·8 | 8·3 | 4·1 | 2·2 | 1·9 |
| Radstock (Somersetshire) | 1·275 | 38·25 | 61·75 | 3·5 | 5·6 | 3·1 | 1·8 | 1·3 |
| Rhonda (South Wales) | 1·278 | 23·8 | 77·2 | 2·7 | 3·5 | 2·3 | 1·2 | 1·1 |
| Denain (Valonciennes, France) | 1·265 | 23·9 ? | 70·1 | 6·0 | 3·5 | 2·4 | 1·3 | 1·1 |
| West Hartley | 1·269 | 35·8 | 64·2 | 4·7 | 7·3 | 1·1 | 0·6 | 0·5 |
| Hastings Hartley | 1·278 | 36·5 | 63·4 | 2·0 | 3·1 | 0·95 | 0·5 | 0·45 |
| Gosforth | 1·260 | 35·0 | 65·0 | 1· | 1·5 | 1·1 | 0·5 | 0·6 |
| South Peareth | 1·266 | 27·8 | 72·2 | 1·8 | 2·5 | 1·2 | 0·6 | 0·6 |
| Garesfield (Bute's) | 1·290 | 28·3 | 71·7 | 3·2 | 4·4 | 0·9 | 0·4 | 0·5 |
| Garesfield (Cowan's) | 1·259 | 29·4 | 70·6 | 0·95 | 1·3 | 0·85 | 0·4 | 0·45 |

| Name of Coal. | Spec. Grav. | Volatile Matters. | Coke. | Ash. | Ash in Coke pr. ct. | Sulphur in | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Coal. | Coke. | Volatile Matters. |
| South Tyne | 1·339 | 36·3 | 63·7 | 3·9 | 6·1 | 2·1 | 1·1 | 1·0 |
| Blenkinsopp | 1·298 | 38·0 | 62·0 | 5·1 | 8·2 | 1·6 | 0·8 | 0·8 |
| Woodthorpe (South Yorkshire) | 1·347 | 33·1 | 66·9 | 10·5 | 16·6 | 1·2 | 0·7 | 0·5 |
| Soap House Pit " | 1·258 | 35·0 | 65·0 | 0·8 | 1·2 | 0·75 | 0·4 | 0·35 |
| Mortomly " | 1·220 | 37·0 | 63·0 | 1·6 | 2·5 | 1·1 | 0·6 | 0·5 |
| Cumberland, No. 1 | 1·294 | 25·5 | 74·5 | 2·1 | 2·8 | 1·3 | 0·7 | 0·6 |
| " No. 2 | 1·275 | 25·6 | 74·4 | 1·4 | 1·9 | 1·1 | 0·6 | 0·5 |
| " No. 3 | 1·290 | 30·9 | 69·1 | 4·0 | 5·8 | 1·7 | 0·8 | 0·9 |
| Ruabon Nant Seam (N. Wales) | 1·269 | 37·9 | 62·1 | 1·4 | 2·2 | 1·1 | 0·7 | 0·4 |
| " Top Yard Seam " | 1·269 | 37·5 | 62·5 | 2·5 | 4·0 | 1·4 | 0·8 | 0·6 |
| " Main Coal " | 1·284 | 41·5 | 58·5 | 1·0 | 1·7 | 0·85 | 0·45 | 0·4 |
| " Yard Seam " | 1·271 | 34·0 | 66·0 | 1·4 | 2·1 | 1·1 | 0·6 | 0·5 |
| Rhonda Low Main (S. Wales) | 1·280 | 28·1 | 76·9 | 2·1 | 2·7 | 2·2 | 1·1 | 1·1 |
| Nailsea (Somersetshire) | 1·312 | 34·9 | 65·1 | 3·0 | 4·6 | 2·85 | 1·5 | 1·35 |
| Silverdale, 10 feet (N. Stafford.) | 1·301 | 34·0 | 66·0 | 1·95 | 2·92 | 1·3 | 0·7 | 0·6 |
| Woodshutts, 7 feet, Banbury(N. S.) | 1·291 | 40·2 | 59·8 | 1·22 | 2·03 | 0·9 | 0·54 | 0·36 |
| Apedale (N. Staffordshire) | 1·307 | 38·5 | 61·5 | 1·9 | 3·1 | 1·5 | 0·82 | 0·68 |
| Apedale 4 feet (N. Staffordshire) | 1·267 | 40·0 | 60·0 | 0·75 | 1·25 | 0·80 | 0·38 | 0·42 |
| Harecastle (Cheshire) | 1·230 | 31·5 | 68·5 | 5·0 | 7·3 | 2·1 | 1·1 | 1·0 |
| St. Helen's (South Lancashire) | 1·285 | 37·2 | 62·8 | 1·2 | 1·91 | 1·1 | 0·54 | 0·56 |
| Staffordshire Cannel | 1·220 | 50·0 | 50·0 | 2·9 | 5·8 | 1·3 | 0·52 | 0·78 |
| Whitecroft (near Lydney, Gloucestershire) | 1·401 | 34·3 | 65·7 | 11·1 | 16·8 | 3·1 | 1·9 | 1·2 |

The following results of Drs. Maclagan, Richardson, and Penny, made public on the occasion of the late trial respecting the nature of Boghead coal or Torbanehill mineral, will corroborate the foregoing table, and complete the list of cannel coal analyses.

ANALYSES OF COALS AND SHALES BY DR. DOUGLAS MACLAGAN, OF EDINBURGH.

| Locality. | Sp.Gr. | Volatile Matter. | Coke, consisting of | | Composition of Ash. |
|---|---|---|---|---|---|
| | | | Fixed Carbon. | Ash. | |
| 1. Boghead Coal, Mean of Three Experiments | 1·209 | 69·70 | 7·73 | 22·57 | Silica, 69. Alumina, Oxide of Iron, Lime, Magnesia, &c. 31–100. |
| 2. Lesmahago Parrot Coal, Mean | 1·230 | 51·44 | 39·57 | 8·98 | Silica, 48. Alumina, &c. 52–100. |
| 3. Capeldrae Parrot Coal | 1·321 | 50·00 | 33·90 | 16·10 | Silica, 53. Alumina, &c. 47–100. |
| 4. Balbardie Parrot Coal | 1·443 | 52·05 | 21·28 | 26·67 | Silica, 70. Alumina, &c. 30–100. |
| 5. Methill Parrot Coal | 1·147 | 69·43 | 21·84 | 8·72 | |
| 6. Rochsoles Co.'s Parrot Coal | 1·161 | 70·59 | 13·14 | 16·27 | |
| 7. Fife Parrot Coal, No. 1 | 1·480 | 45·50 | 32·55 | 21·95 | |
| " No. 2 | 1·327 | 46·56 | 39·55 | 13·89 | |
| 8. Cherry Coal, from Torbanehill Parrot | — | 42·16 | 40·90 | 16·94 | Silica, 65. Alumina, &c. 35–100. |
| 9. Torbanehill Top of House Coal | 1·327 | 32·27 | 64·80 | 2·92 | |
| 10. Torbanehill Bottom of House Coal | 1·401 | 28·11 | 42·22 | 27·28 | Silica, 78. Alumina, &c. 22–100. |
| | | Combustible Matter, Moisture. | | | |
| 11. Shale, from Stirlingshire Coal Field | 2·344 | 16·53 | — | 83·47 | Silica, 78. Alumina, &c. 22–100. |
| 12. Birtledean Shale, Lancashire | 2·390 | 16·84 | — | 83·16 | Silica, 82. Alumina, &c. 18–100. |
| 13. Pendleton Shale, ditto | 2·642 | 22·53 | — | 77·47 | |
| 14. Fife "Rums" | 1·694 | 26·74 | 20·51 | 52·75 | |

SCOTCH COALS, ASSAYED BY DR. RICHARDSON, OF NEW CASTLE.

| | | | | |
|---|---|---|---|---|
| Boghead Coal, Top of Seam | — | 64·62 | 15·22 | 20·16 |
| " Bottom of Seam | — | 67·59 | 10·90 | 21·51 |
| Rochsole Co.'s Coal | — | 63·94 | 17·95 | 18·11 |
| Methill Coal | — | 63·68 | 18·82 | 17·50 |

VARIOUS CANNEL COALS, ANALYSED BY DR. PENNY.

| CANNEL OR PARROT COALS. | COAL. | | | | | | COKE. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sp. Gr. | Volatile Matters. | Fixed Carbon | Ash. | Sulphur. | Water | Total amount of Coke in Coal. | Carbon in Coke. | Ash in Coke. |
| | | Per Ct. | Per Ct. | PerCt. | PerCt. | PerCt. | Per Ct. | Per Ct. | PerCt. |
| 1. Rochsoles (1851) | 1·443 | 53·7 | 4·9 | 38·8 | 1.6 | 1· | 42·3 | 11·58 | 88·42 |
| 2. Hardie's (1852) | 1·420 | 34· | 4· | 58·4 | * | 3·5 | 62·4 | 06·44 | 93·56 |
| 3. Boghead, Brown (1851) | 1·160 | 71·06 | 7·10 | 26·2 | ·24 | ·4 | 28·3 | 25·09 | 74·91 |
| 4. Boghead, Black (1851) | 1·2185 | 62·7 | 9·25 | 26·5 | ·35 | 1·2 | 35·75 | 25·88 | 74·12 |
| 5. Torbanehill (1853) | 1·1892 | 57·11 | 10·52 | 21· | ·32 | 1·05 | 31·52 | 33·38 | 66·62 |
| 6. Boghead (1849) | 1·1550 | 71·3 | 11·3 | 16·3 | (·34) | ·6 | 29·1 | 40·22 | 59·78 |
| 7. Bathville | 1·201 | 64·35 | 12·6 | 22·2 | ·25 | ·60 | 34·80 | 36·21 | 63·79 |
| 8. Stan (Ayshire) | 1·4647 | 52·08 | 14·77 | 32· | * | 1·15 | 46·77 | 31·52 | 68·48 |
| 9. Methill | 1·3002 | 49·28 | 17·57 | 29·7 | * | 3·50 | 47·27 | 37·17 | 62·83 |
| 10. Capeldrae | 1·3608 | 45·73 | 19·97 | 31·5 | * | 2·80 | 51.47 | 38 80 | 61·20 |
| 11. Wemyss | 1·1831 | 58·52 | 25·28 | 14·25 | * | 1·95 | 39·53 | 63·95 | 36·05 |
| 12. Balbardie (1852) | 1·420 | 38·96 | 29·66 | 28· | ·38 | 3·0 | 57·66 | 43·56 | 51·44 |
| 13. Hillhead (Kilmarnock) | 1·602 / 1·320 | 36·65 | 32·34 | 27·4 | ·61 | 3· | 59·74 | 54·14 | 45·86 |
| 14. Brymbo | * | 32·10 | 36·4 | 29·4 | * | 2·1 | 65·80 | 55·32 | 44·68 |
| 15. Lesmahagow (Auchinheath) | 1·1990 | 56·28 | 36·7 | 4·8 | ·55 | 3·15 | 41· | 89·50 | 10·50 |
| 16. Bartonshill | 1·280 | 48· | 39·6 | 10· | 2· | 2·4 | 49·6 | 79·84 | 20·16 |
| 17. Bartonshill | 1·350 | 38· | 37·9 | 18·7 | 2·2 | 3·2 | 56·6 | 66·96 | 33·04 |
| 18. Stevenson (Ayrshire) | 1·3850 | 40·21 | 40·14 | 19·35 | * | ·3 | 59·49 | 67·64 | 32·36 |
| 19. Lesmahagow (Southfield) | 1·226 | 49·34 | 40·97 | 6·34 | 1·35 | 2· | 47·31 | 86·60 | 13·40 |
| 20. Knightswood | 1·284 | 44·77 | 41·18 | 11·05 | * | 3·05 | 52·18 | 78·83 | 21·17 |
| 21. Cairnbroe | 1·247 | 42·83 | 42·67 | 8·50 | * | 6· | 51·17 | 83·39 | 26·61 |
| 22. Skaterigg | 1·252 | 49·32 | 54·68 | 2·50 | * | 3·35 | 47·33 | 94·42 | 5·58 |
| 23. Cowdenhill | 1·299 | 46·0 | 45· | 5· | ·50 | 3·50 | 50· | 90· | 10· |
| 24. Breadisholme | 1·335 | 39· | 48·5 | 8·1 | ·4 | 4· | 56·6 | 85·69 | 14·31 |
| 25. Ruchill | 1·223 | 45 78 | 49·27 | 2·5 | * | 2·5 | 51·77 | 95·17 | 4·83 |
| 26. Kelvinside | 1·231 | 40·17 | 58·42 | 1·9 | ·21 | 4·3 | 55·32 | 96·57 | 3·43 |

* Not estimated.

The inspection of these tables shows that the cannel coals yield, on distillation, a very much larger amount of volatile matter, less coke, a larger quantity of ash, and generally more sulphur, than the bituminous class, while no anthracite is included in the table from the circumstance of its affording little or no volatile matter, and, therefore, being quite inapplicable to gas making.

With reference to the volatile matter produced from cannel coal, we shall also find that it is of superior quality for illuminating purposes, while the coke is often so intimately mixed with earthy matter, or contains so little carbon and combustible matter, as to be of little or no value as fuel.

The ash of the cannels will be found to consist chiefly of silicate of alumina, and has been observed to bear a remarkable analogy to decomposed felspar, from which a portion of silicate of potash has been washed out; leading to the inference, when considered in connection with its large relative amount, that these varieties have been formed by the decomposition of an accumulation of the lower order of vegetables, such as mosses, lichens, sea-weed, &c., deposited with the débris of the older rocks; while the occurrence of muriate of ammonia, and occasionally of hydriodate of ammonia, as observed by M. Bussy in the coal and products of distillation, point to a marine origin of the vegetable remains, or to a submergence below the waters of the sea.

The ash of bituminous coal consists generally of silicate and

sulphate of lime, with oxide of iron and some argillaceous matter, the greater portion of which may have formed in the natural ash of the large trees to which the formation owes its origin, and which are known to belong to a class (*Equisetaceæ*), yielding a silicious ash.

The sulphur will be generally found, with some marked exceptions, in larger quantities in the cannels than in the bituminous coals, and a larger portion passes off with the volatile ingredients on distillation, part being in the form of sulphuretted hydrogen, but more as the bisulphuret of carbon. This circumstance has led to the conclusion that the sulphur in cannel coal is not derived exclusively from iron pyrites, as in bituminous coal, but exists in some other form of combination, from which it is evolved at a lower temperature, and thus enabled to enter more readily into combination with carbon. Bituminous coal is never entirely free from iron pyrites, or the bisulphuret of iron, and when much water is mechanically mixed with the coal as it is placed in the retort, or there is a large proportion of oxygen in its composition, which produces water with the hydrogen, and particularly if a very high temperature be employed in the process, this ingredient is converted, by mutual decomposition with steam, into peroxide of iron and sulphuretted hydrogen. Carbonate of lime frequently accompanies the layers of coal, forming thin bands between the seams, and may often be of service to the gas-maker in diminishing the amount of sulphuretted hydrogen evolved. At the temperature of the gas retort the carbonic acid is expelled, which becomes partly converted into carbonic oxide by contact with red-hot coke, while the calcium combines with the sulphur of the sulphuretted hydrogen, becoming sulphuret of calcium, which remains in the coke.

Although prejudicial as a source of carbonic acid and carbonic oxide, carbonate of lime may thus effect a partial separation of sulphur from the gas.

It is a most fortunate circumstance that no compounds of arsenic have ever been found associated with the iron pyrites of the coal fields, although they frequently accompany this mineral in other formations. Had this not been the case, a most serious objection would have arisen to the use of coal-gas for domestic purposes, and great difficulties have been thrown in the way of its purification, even if sanitary precautions would ever have permitted a gas to be used which was liable to evolve in burning so virulent a poison as arsenious acid.

The natural moisture in the coal, which varies from 1 to 14 per cent. in different samples, is a serious obstacle to contend with in gas-making, as to it the greater portion of the carbonic acid which accompanies the gaseous mixture must be attributed, and the cost of purification becomes proportionally increased. Aqueous vapor in contact with red-hot charcoal becomes converted

into carbonic acid and carbonic oxide, while the bisulphuret of iron is much more readily converted in its presence into sulphuretted hydrogen and the peroxide.

It will at once be seen from the foregoing tables, that cannel coal is very far superior to all others in the proportion of volatile matter yielded; but as all the volatile matter afforded by coal is not combustible, it does not necessarily follow that the coal which yields the largest amount of gas is the most valuable gas-coal, although such is generally the case, as will be seen by the following tables taken from Mr. Hughes on "Gas Works."

| Description of Coal. | Cubic feet of gas per ton of coal. | Specific gravity of the gas. | Weight of gas in lbs. avoirdupois per ton of coal. | Authority. |
|---|---|---|---|---|
| *Newcastle Coals.* | | | | |
| Small Coal | 8,000 | ·420 | 257 | Dr. Fyfe. |
| Newcastle Coal | 11,648 | ·475 | 423 | Mr. Joseph Hedley. |
| Pelaw Main, Newcastle | 11,424 | ·444 | 389 | Ditto. |
| Pelton Main, Newcastle | 11,424 | ·437 | 382 | Ditto. |
| Blenkinsopp, Carlisle | 11,200 | ·521 | 447 | Ditto. |
| Newcastle | 8,500 | ·412 | 268 | London, 1887. |
| Wallsend, Newcastle | 12,000 | ·490 | 450 | Quantity made in the revolving web retort; authority, Mr. Clegg. |
| Pelton Main | 11,000 | ·430 | 363 | Author of the "Chemistry of Gas-Lighting," in the "Journal of Gas-Lighting." |
| Leverson | 10,800 | ·425 | 358 | |
| Washington | 10,000 | ·430 | 330 | |
| Pelaw Main | 11,000 | ·420 | 355 | |
| New Pelton | 10,500 | ·415 | 335 | |
| Dean's Primrose | 10,500 | ·430 | 347 | |
| Garesfield | 10,500 | ·398 | 321 | |
| Gosforth | 10,000 | ·402 | 308 | |
| West Hartley | 10,500 | ·420 | 339 | |
| Hasting's Hartley | 10,300 | ·421 | 333 | |
| Blenkinsopp | 9,700 | ·450 | 335 | |
| Berwick and Craister's Wallsend | 12,507 | ·470 | 449 | Mr. Clegg. |
| Pelaw Main | 12,400 | ·420 | 399 | Ditto. |
| Russell's Wallsend | 12,000 | ·418 | 384 | Ditto. |
| Ellison's Main | 11,200 | ·416 | 357 | Ditto. |
| Felling Main | 11,200 | ·410 | 351 | Ditto. |
| Pearith's Wallsend | 11,147 | ·410 | 350 | Ditto. |
| Dean's Primrose | 11,120 | ·410 | 349 | Ditto. |
| Benton Main | 10,987 | ·400 | 337 | Ditto. |
| Eden Main | 10,400 | ·400 | 318 | Ditto. |
| Heaton Main | 10,400 | ·410 | 326 | Ditto. |
| | 9,000 | — | — | Average production by Phœnix Gas Company for year 1848. |
| *Parrot or Cannel Coals.* | | | | |
| Yorkshire Parrot | 11,500 | — | — | Dr. Fyfe. |
| Wigan Cannel | 9,500 | ·460 to ·520 | 357 | Ditto. |
| Scottish Parrot | 9,500 | ·640 | 466 | Ditto. |
| Ramsay's Newcastle Cannel | 9,746 | ·554 to ·580 | 423 | Ditto. |
| Loch Gelly Parrot | 9,123 | ·567 | 396 | Ditto. |
| Lesmahago Cannel, 1st experiment | 11,681 | ·540 | 488 | Mr. Wright. |
| Ditto, ditto, 2d experiment | 9,878 | ·650 | 492 | Ditto. |
| Ramsay's Newcastle Cannel | 9,016 | ·604 | 417 | Ditto. |
| Ditto ditto | 9,388 | ·598 | 427 | John Kay, Manager of Dundee Gas Works. |
| Ditto ditto | 9,667 | ·731 | 541 | Dr. Leeson, Dr. Miller, and Mr. G. H. Palmer. |
| Lesmahago Cannel | 11,812 | ·737 | 638 | Mr. Joseph Hedley. |
| Welsh Cannel | 11,424 | ·737 | 645 | Ditto. |
| *Wigan* Cannel | 11,200 | ·606 | 520 | Author of "Chemistry of Gas-Lighting." |

| Description of Coal. | Cubic feet of gas per ton of coal. | Specific gravity of the gas. | Weight of gas in lbs. avoirdupois per ton of coal. | Authority. |
|---|---|---|---|---|
| Wigan Cannel | 9,500 | ·580 | 422 | Liverpool New Gas and Coke Company. |
| Wemyss Cannel | 10,976 | ·670 | 563 | Mr. Wright. |
| Ditto ditto | 10,192 | ·691 | 588 | Ditto. |
| Wigan Cannel | 9,408 | ·478 | 344 | Ditto. |
| Knightswood Cannel | 9,720 | ·590 | 439 | Ditto. |
| Boghead Cannel | 15,000 | ·752 | 866 | Mr. F. J. Evans, at Westminster Station of Chartered Gas Company.* |
| Lesmahago, No. 1 | 13,500 | ·642 | 666 | Ditto. |
| Ditto No. 2 | 13,200 | ·618 | 627 | Ditto. |
| Capeldrae Cannel | 14,400 | ·577 | 639 | Ditto. |
| Arniston Cannel | 12,600 | ·626 | 606 | Ditto. |
| Ramsay Cannel | 10,800 | ·549 | 488 | Mr. F. J. Evans. |
| Weymss Cannel | 14,800 | ·580 | 687 | Ditto. |
| Kirknees Cannel | 12,800 | ·562 | 553 | Ditto. |
| Knightswood Cannel | 13,200 | ·550 | 559 | Ditto. |
| Wigan (Ince Hall) Cannel | 11,400 | ·598 | 461 | Ditto. |
| Pelton Cannel | 11,500 | ·520 | 459 | Author of "Chemistry of Gas-Lighting." |
| Leverson Cannel | 11,600 | ·523 | 466 | Ditto. |
| Washington Cannel | 10,500 | ·500 | 408 | Ditto. |
| Wigan Cannel | 14,458 | ·640 | 709 | Mr. Clegg. |
| Ditto ditto | 14,267 | ·610 | 664 | Ditto. |
| Scotch Cannel | 14,000 | ·580 | 622 | Ditto. |
| Ditto ditto | 13,813 | ·500 | 529 | Ditto. |
| *Derbyshire, Welsh, Staffordshire, and other kinds of Coal.* | | | | |
| Derbyshire Deep Main | 9,400 | ·494 | 308 | Mr. Wright. |
| Brymbo 2-yard Coal | 8,880 | ·463 | 315 | Ditto. |
| Powell Coal, 2 cwt. charges every five hours | 10,165 | ·459 | 357 | Ditto. |
| Powell Coal, 1½ cwt. charges every five hours | 8,250 | ·470 | 296 | Ditto. |
| Bickerstaff, Liverpool | 11,424 | ·475 | 415 | Author of "Chemistry of Gas-Lighting." |
| Neath, South Wales | 11,200 | ·468 | 401 | Ditto. |
| Birmingham Gas Company: Lump Coal from West Bromwich | 6,500 | ·455 | 227 | Birmingham Gas Company. Parliamentary return. |
| West Bromwich | 6,500 | ·455 | 227 | Birmingham and Staffordshire. Ditto. |
| Macclesfield | 6,720 | — | — | |
| Stockport | 7,800 | ·589 | 322 | Parliamentary return. |
| Oldham, Watergate, and Wigan Cannel mixed | 9,500 | ·584 | 383 | Manchester. Ditto. |
| Ormskirk, or Wigan Slack | 8,200 | ·462 | 290 | Liverpool, Old Company. Ditto. |
| Low Moor, mixed with two kinds of Slack | 8,000 | ·420 | 257 | Bradford. Ditto. |
| Leeds Coal | 6,500 | ·530 | 268 | Leeds Company. Parliamentary return. |
| Cannel and Common Coal mixed | 8,000 | ·466 | 285 | Sheffield Company. Parliamentary return |
| Derbyshire Soft Coal | 7,500 | ·528 | 308 | Leicester. Ditto. |
| Ditto ditto | 7,000 | ·448 | 240 | Derby. Ditto. |
| Ditto ditto | 7,000 | ·424 | 227 | Nottingham. Ditto. |
| *Staffordshire.* | | | | |
| South's | 10,938 | ·398 | 383 | Mr. A. Wright. |
| Second variety | 10,667 | ·395 | 323 | Ditto. |
| Third variety | 10,667 | ·390 | 318 | Ditto. |
| Fourth variety | 9,600 | ·320 | 285 | Ditto. |
| Forest of Dean | 10,133 | ·350 | 271 | Ditto. |
| Second variety | 10,133 | ·360 | 279 | Ditto. |
| *Welsh Coal.* | | | | |
| First variety | 10,000 | ·395 | 295 | Ditto. |
| Second variety | 10,133 | ·380 | 295 | Ditto. |

* Each of the results given by Mr. Evans is the mean of three experiments.

Some practical gas engineers are of opinion that the quantities n the above tabl e are larger than are usually obtained in the works. The following table by Mr. Wright, in which the results of experiments on the distillation of cannel coals are placed in a very practical commercial form, will be found interesting.

| | NAME OF COAL. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lesmahago Cannel. | | Ramsay's Newcastle Cannel. | Derbyshire Deep Main. | Wemyss Cannel. | | Wigan Cannel. |
| | Exp. 1. | Exp. 2. | | | Exp. 1. | Exp. 2. | |
| | Pounds per ton. | Pounds per ton. | Pounds per ton. | Pounds per ton. | Pounds per ton. | Pounds per ton. | Pounds per ton. |
| Coke | 1091· | 1064· | 1485· | 1335· | 1124·5 | 1188· | 1326·0 |
| Gas | 463· | 488·5 | 410· | 300· | 551·4 | 528· | 338·0 |
| Tar | 594· | 603 | 295· | 219· | 224·0 | 197· | 250·0 |
| Ammonia and Water | 4·5 | 4·5 | 6·72 | 179· | — | — | — |
| Loss | 87·5 | 85· | 28·28 | 207· | 340·1 | 327· | 326·0 |
| | 2240· | 2240· | 2240· | 2240· | 2240· | 2240· | 2240· |
| Cubic feet of Gas | 11·631 | 9·378 | 9·016 | 9·400 | 10·976 | 10·192 | 9·408 |
| Specific Gravity | 0·540 | 0·650 | 0·604 | 0·424 | 0·670 | 0·691 | 0·473 |
| Illuminating Power, Gas of Sp. gr. 0 86 being 1 | — | 2·33 | 2· | 0·8 | 2·47 | — | 1·5 |

The following tables by Dr. Fyfe contain, in addition to the quantities of gas afforded by the coals, much valuable information upon the relative illuminating values of the gases, to the consideration of which we shall return in a future page.

| COALS. | Cubic feet of Gas per Ton. | Comparative Value of Coals per Ton, by Quantity of Gas. | Specific Gravity of Gas, Air = 1000. | Condensation by Chlorine per Cent. | Duration by Jet, Five-Inch Flame. | Comparative Value of Gas by Chlorine. | Comparative Value of Gas by Durability. | Comparative Value of Gas by Chlorine and Durability. | Comparative Value of Coals per Ton, taking Quantity of Gas condensed by Chlorine, and Durability, into account. |
|---|---|---|---|---|---|---|---|---|---|
| English Cannel:— | | | | | M. S. | | | | |
| Yorkshire | 11500 | 1·28 | ·451 | 7·66 | 45· | 0·85 | 0·92 | 0·78 | 1·00 |
| Scotch Cannels:— | | | | | | | | | |
| Knightswood | 8960 | 1·00 | ·557 | ·9 | 48· | 1·00 | 1·00 | 1·00 | 1·00 |
| Lochgelly | 9123 | 1·01 | ·567 | 14·5 | 65·30 | 1·66 | 1·36 | 1·95 | 1·11 |
| Marq. Lothian | 10000 | 1·11 | ·556 | 13· | 60· | 1·44 | 1·25 | 1·80 | 2·00 |
| Torryburn | 11200 | 1·24 | ·624 | 13· | 57·30 | 1·44 | 1·19 | 1·71 | 2·13 |
| Monkland | 10190 | 1·13 | ·667 | 16· | 67· | 1·77 | 1·4 | 2·01 | 2·29 |
| Arniston | 10640 | 1·18 | ·637 | 17·5 | 68·30 | 1·94 | 1·41 | 2·03 | 2·41 |
| Wemyss | 10080 | 1·12 | ·642 | 19·5 | 75· | 2·16 | 1·56 | 2·24 | 2·54 |
| Kirkness | 9620 | 1·07 | ·711 | 20·75 | 80·18 | 2·30 | 1·67 | 2·40 | 2·58 |

This table shows the quantity of gas afforded from a ton of each of the coals; the specific gravity of the gas; the amount of condensible matter by chlorine; the durability of the gas when burned by a single jet, with a five inch flame; the comparative

value of the gas for affording light, as shown by the chlorine test, by the durability, and by these taken together, which, when this test is had recourse to, is the proper method to follow. It shows also the comparative value of the coals for the purpose of illumination by the combustion of their gases, as proved by the quantity of gas afforded by each, and also by the quantity and quality taken together.

| COALS. | Cubic Feet of Gas per Ton. | Specific Gravity of Gas, Air = 1000. | Condensation by Chlorine, per Cent. | Durability by Jet, Five-Inch Flame. | Illuminating Power, 1 Foot, Sperm Candles = 120 grs. per Hour. | Value of 1 Foot in grains Sperm. | Comparative Value of 1 Foot in grains Sperm. | Value of 1 Ton of Coals in Pounds of Sperm. | Comparative Value of Coals | Pounds of Coke per Ton of Coal. | Fixed Carbon per Cent in Coal. | Ashes per Cent in Coal. | Pounds of Sulphur per Ton of Coal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENGLISH CORING:— | | | | M. S. | | | | | | | | | |
| Pelton | 9746 | 555 | 6·5 | 50·40 | 3·125 | 382·2 | 1· | 532· | 1· | 1563 | — | — | — |
| ENGLISH CANNEL:— | | | | | | | | | | | | | |
| Ramsay's Newcastle. | 9692 | 625 | 13·25 | 60·40 | 3·33 | 399 6 | 1·04 | 553· | 1·04 | 1520 | — | — | — |
| Wigan | 12010 | 566 | 9·9 | 52·5 | 3·04 | 365·4 | 0·95 | 627·4 | 1·17 | 1360 | 55· | 7·1 | — |
| SCOTCH CANNEL:— | | | | | | | | | | | | | |
| Donibristle | 9923 | 593 | 9· | 51·5 | 7·51 | 901·2 | 2·35 | 1277·5 | 2·4 | 1220 | 49·22 | 4·28 | 8·5 |
| Lesmahago | 10176 | 669 | 17· | 60· | 8·77 | 1058·8 | 2·75 | 1539·5 | 2·87 | 1360 | 42·44 | 4· | — |
| Capeldrae I | 11500 | 644 | 18· | 65 25 | 8·312 | 997·4 | 2·61 | 1638·7 | 3·08 | 9999 | 33·2 | 7·7 | 7·7 |
| Ditto II | 9670 | 650 | 17·8 | 73·37 | 10·01 | 1201·2 | 3·24 | 1670·3 | 3·18 | 1256 | 23 9 | 24·5 | |
| Bogbead | 15426 | 726 | 23·37 | 84·44 | 10·38 | 1245·6 | 3·25 | 2755·6 | 4 3 | 760 | 9·25 | 21·75 | 3· |

This table shows the quantity of gas afforded from a ton of each of the coals; the specific gravity of the gases; the amount of matter condensible by chlorine; the time that a cubic foot will burn from a single jet, with a flame of five inches in length; the illuminating power of the gas compared with that of a spermaceti candle consuming 120 grains per hour, as shown by Bunsen's photometer; and the value of a foot of gas in grains of spermaceti; also the value of a ton of coals for affording light by the combustion of its gas, given in lbs. of spermaceti; the quantity of coke and of sulphur per ton of coal; and the percentage of fixed carbon, and of ashes, are also given.

The decomposition of the coal begins a little below a red heat, and continues when large quantities are employed, for several hours, the quantity of gas gradually diminishing towards the end. According to Peckston, in an eight hours' distillation the relative quantities of gas given off are, in the first hour 20, in the second 15, in the third 14, in the fourth nearly 13, in the fifth 12, in the sixth 10, in the seventh 9, and in the eighth about 8 per cent. of the whole quantity, when the fire is uniform and the vessels are constantly at a red heat. The cubic foot at the end, therefore, costs 2½ times as much as at the beginning. The quality of the gas at the different periods of the distillation, however, must also be taken into consideration.

For this purpose it will be well again to direct attention to the ingredients of the gaseous mixture: this consists, after the separation of the tar and the aqueous liquid, of *olefiant gas*, *light carburetted hydrogen*, *carbonic oxide*, *hydrogen*, *vapors of the volatile oils of tar*, *sulphuret of carbon*, *ammonia*, *sulphuretted hydrogen*, *carbonic acid*, *cyanogen*, *sulpho-cyanogen*, *hydrochloric acids*, *aqueous vapor*, and *nitrogen*. The carbonic oxide and a part of the free hydrogen have doubtless the same origin, being formed from the moisture in the coal, or from the first portions of aqueous vapor that are generated passing over the red-hot coke. The nitrogen of the coal is converted entirely into cyanogen and ammonia, which are partly in combination, while the latter is also found combined with sulpho-cyanogen and the other acids forming volatile salts; the *free* nitrogen, on the contrary, is the residue of atmospheric air contained in the retort. Sulphuretted hydrogen and sulphuret of carbon are due to the sulphur and iron pyrites in the coal. The first four of the ingredients named, with the illuminating vapors of tar oil, form the proper bulk of the gas; the others are impurities, and being only present in small quantity, should have been separated in the process of purification. It has been found by experience that the relative proportions of these four ingredients vary with the duration of the distillation, and that the illuminating portion of the gas is evolved during the earliest stage of the process. When chlorine is added to coal-gas, it forms with the olefiant gas and the vapors of tar oil—with those constituents, therefore, upon which the illuminating power depends—a fluid compound, which separates, and the original volume is consequently diminished. The diminution which the volume of the gas suffers when mixed with chlorine is, therefore, in direct proportion to its illuminating power, and to the value of the gas—to the amount of olefiant gas (and tar-oil vapors) which it contains. This explains a portion of the table of Dr. Fyfe, given above, and also the following experiments of Henry, who was the first to publish a correct and trustworthy description of the entire process of gas-making, by analysing carefully, step by step, the various products as they were evolved. Henry found that below a cherry-red heat, almost nothing but hydrogen, atmospheric air, and some tar passed off, with hardly any illuminating gas, but at that temperature illuminating gas alone appeared, and this was composed of a mixture of gases in the following relative proportions:

| Time of Collection. | Specific Gravity. | Absorbed by Chlorine. | Light Carburetted Hydrogen. | Carbonic Oxide. | Hydrogen. | Nitrogen. |
|---|---|---|---|---|---|---|
| | | out of 100 parts of Gas from Wigan Cannel Coal. | | | | |
| In the first hour | 0·650 | 18 | 82·5 | 3·2 | 0 | 1·3 |
| | 0·620 | 12 | 72 | 1·9 | 8·8 | 5·3 |
| | 0·630 | 12 | 58 | 12·3 | 16 | 1·7 |
| 5 hours after the commencement | 0·500 | 7 | 56 | 11 | 21·3 | 4·7 |
| 10 | 0·345 | 0 | 20 | 10 | 60 | 10 |

As a general result, therefore, the carburetted hydrogen is by far the most abundant product, and the most luminous portion, which is condensible by chlorine, comprises only about one fifth of the whole. These numbers also prove distinctly that after about the fifth hour an addition to the quantity alone is made, while the quality does not improve, but, on the contrary, is so rapidly deteriorated, that at the expiration of ten hours the gas which passes over is hardly luminous when ignited, burning with a very faint blue flame. The specific gravity, as will also be seen, keeps pace with the quality of the gas, and can thus far be taken as a test of its value. As pure olefiant gas has about the specific gravity of the air (0.98), the density of an illuminating gas must increase with the quantity of olefiant gas contained in it; yet an extraordinary amount of carbonic oxide (sp. gr. = 0.97) or of carbonic acid (sp. gr. = 1.52) may give rise to errors of some magnitude. The immense increase of hydrogen, which at this last period amounts to 60 per cent., is remarkable, and very important to the manufacturer, as this increase is no longer due to the decomposition of aqueous vapors alone, but to that of the carbo-hydrogens themselves. In accordance with an old observation, these gases are decomposed at a high red heat, depositing a portion of their carbon on the sides of the vessel, and more recent experiments of Marchand shows the progress of this decomposition very clearly. When olefiant gas was conducted through a red-hot tube and the heat constantly augmented, the gas passing off, collected in successive portions, contained the following quantities of carbon to 100 of hydrogen:—

| Hydrogen: | Carbon. | Nature and Temperature of the Gas. | Hydrogen: | Carbon. | Nature and Temperature of the Gas. |
|---|---|---|---|---|---|
| 100 : | 614 | Olefiant gas. | 100 : | 867 | |
| 100 : | 580 | Red heat. | 100 : | 825 | Intense white heat. |
| 100 : | 583 | | 100 : | 807 | Light carburetted hydrogen. |
| 100 : | 472 | | 100 : | 7 | Continued white heat (nearly pure hydrogen). |

It is evident that this decarbonization is at last complete, and that the illuminating power of the gas must suffer in proportion. The amount of carbon deposited is found to increase with the degree of heat, the extension of the red-hot sides of the retort, and the time that the gas is in contact with them. When the whole charge of a retort becomes converted into red-hot coke, and even from the very commencement of the distillation, the retorts being maintained at a red heat, the carbo-hydrogens must always pass over red-hot surfaces, before they can reach the conducting tube, and hence, although only for a short time, they deposit carbon.

The best product is obtained when dry coal only is used, and when the retorts are kept at a cherry-red heat throughout the process, the coke being discharged after the expiration of five or

more hours, when the illuminating power of the gas begins to diminish. It must not be supposed, however, that the gas is directly produced from the coal, for observation leads to the conclusion that tar is the first product, which is subsequently decomposed and partially converted into gas. If the temperature does not rise above a red heat, tar is produced in great quantities, with little or no gas.

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ART. III.—VISIT TO THE LAKE SUPERIOR REGION, IN 1854.*—By Prof. E. RIVOT, of the French School of Mines.

NORTH America is admirably divided in respect to its mineral wealth. On the west, California and the adjoining territories possess gold and mercury, the recent discovery of which has become known to all the world; on the east, in that part of the continent known as the Old States of the Union, are immense deposits of anthracite and bituminous coal, and the ores of iron, copper, zinc, lead, with salt and veins of gold and silver. The surface of the country is covered to a vast extent with the original forest, the clearing of which advances with incredible rapidity. The character of the surface is such as to allow the construction in a short time, of very easy and cheap methods of transportation, such as have required in Europe a long period, and a vast expense to make.

### COAL.

The carboniferous formation on the east of the Alleghanies, extends from Pennsylvania in the north, to Alabama, and presents numerous and immense beds of excellent fuel, consisting of anthracite, which burns without a blaze, bituminous and semi-bituminous coal. The rivers, the great lakes, the canals, the railroads, afford means for its transportation, at small expense, to all parts of the Union.

The same formation exists west of the Alleghanies, in Illinois, Iowa, Missouri, and probably it extends even into Arkansas, underlying in part a more recent series. The existence of a similar coal basin in the State of Michigan, has been established, but so far as examined at this time, it has proved to be of an inferior quality. In this vast development of the carboniferous series which guarantees the future industrial wealth of America, the mines of Pennsylvania are the only ones now extensively worked. They furnish fuel to the cities on the sea-coast, and in the interior.

* Translated for the Mining Magazine.—Copyright secured.

### IRON ORE.

The coal series of the east and the west contains vast beds of the carbonate of iron, in Pennsylvania, Ohio, Tennessee, Virginia Alabama, &c. These ores are rich, of good quality, and produce excellent iron.

Ores of iron of every kind and quality, are to be found in extensive beds, in the geological formations of the States of the Union. They border upon the carboniferous series, or upon immense virgin forests, and often have their fluxes deposited close at hand. So far as regards the raw materials, the manufacture of cast and wrought iron can be carried on under very favorable circumstances.

The high price of labor, the lack of the right class of workmen, and the deficiency of engineers experienced in this difficult branch of manufacture, form the chief embarrassments, and cause the iron-founders to seek such protection as shall enable them to compete with England. Under a system of free-trade, England can send to the United States large quantities of cast and wrought iron, notwithstanding that country is so incomparably rich in wood, coals, and iron ores.

This abnormal state of things may continue some time; for the price of labor shows no tendency to decline, and the constantly increasing development of industrial enterprises of every kind will rather cause a relative advance in the wages of important workmen.

### LEAD ORES.

Lead ore is found chiefly in Illinois, Iowa, Missouri, Wisconsin, and seems to form highly important veins. They are not very actively worked, chiefly, perhaps, in consequence of the sparseness of the population.

However, this is not the only cause, for the veins of galena, even in New York State, are not energetically worked. The galena, although a little argentiferous, does not command a sufficiently high price to secure immediate and large profits, which is the prime point in all American enterprises. For some years past England has supplied North America with considerable quantities of lead.

### ZINC ORES.

The United States produce very little zinc, although this ore is abundant. Calamine, brucite, and blende exist in veins, and considerable masses in Illinois and New Jersey, and probably in many other States. Attention is turning to this ore, and at a day not far distant, many establishments will probably be erected, and furnish all of this metal which the country may require.

GOLD.

Gold exists in veins and in the placers of California. Virginia and Carolina contain less important deposits, which are worked with much enterprise.

SALT.*

Salt is manufactured in abundance in the State of New York. The highly impregnated springs in Onondaga County have long been known.

COPPER.*

The ores of copper are mined in New York, Carolina, and Virginia. They are the copper pyrites which is very rich and pure. They are smelted at Boston, and also exported from the country.

Their importance vanishes before that of the veins of copper and native silver of Lake Superior, which have been worked for the last ten years, and which will yield in 1855 more than three thousand tons of copper.

The copper mines of Lake Superior have been the sole subject of my visit to the country. Hence I shall confine my remarks entirely to the mineral wealth of that portion of the country.

HISTORICAL STATEMENT.

The Indians appear to have worked them from a very early period. They obtained considerable quantities of copper, which they used for weapons, implements, and as an object of exchange. Their operations have been brought to light by the miners. Their antiquity is established by the depth of the soil upon their workings, and by the size of the trees which have subsequently grown up over them.

These old workings were first ascribed to another race than the Indians, but their uniform character, the means used to separate pieces of copper, fire and stone-hammers, the certainty that the Indians have mined, all render this hypothesis very improbable, and do not allow us to believe in the existence of a race more elevated than the Red men.

We find in books published in the seventeenth century, treating upon Canada, very positive evidence of the existence of native copper on the shores of Lake Superior, and of mining for that metal by the Indians.

The most striking work is that of the Jesuit Fathers published

* The American reader will notice that M. Rivot mentions only a few of the localities where many of these minerals are mined. This is in consequence of his attention having been devoted exclusively to the Lake Superior *region*.—Ed.

under the following title:—"*Relation de ce qui s'est passé à la Nouvelle France dans les missions des PP. de la Compagnie de Jesus, depuis* 1632 *jusqu'en* 1772."

These narratives contain the notes of the journeys of the missionaries Raymbault, Jogues, Réné Mesnard, Allvaez, Dablon, Marquette, &c.

These energetic men, animated by religious zeal, did not fear to travel alone through the territories of Lake Superior, and of Michigan, seeking only to convert to the Christian religion, the inhabitants of those virgin forests.

Many of them were men of accomplished education, for the chart of Lake Tracy or Superior, published in 1669, under their direction, is remarkably accurate. We cannot withhold our admiration of the invincible energy which led these religious men single-handed through these savage countries, which are even at this day of such difficult access.

The narratives of the Jesuit Fathers show that the Indians came at certain periods to work the native copper on the shores of Lake Superior, and that their religious chiefs retained the direction of these enterprises as a means of securing influence. The missionaries relate a great many legends and superstitious traditions, circulated among the Indians, and respecting which they enjoined upon them to observe the greatest secrecy in the presence of the strangers.

Many missions were established by the Jesuits at the Saut Ste. Marie, at Mackinaw, at the Point, &c., all of which locations were admirably selected. At their suggestion, the governor of New France, M. de Tallon, took possession of all these territories in the name of the king. This ceremony was performed in May, 1671, at Saut Ste. Marie, by M. de Lussan, in presence of Father Marquette, and a numerous assembly of Indian tribes.

The efforts of the missionaries, and the taking possession of the country in the name of the king, were entirely fruitless. The country passed under the dominion of England in 1763, together with Canada. The present generation has preserved no other token of remembrance of the Jesuits and of France, than traditions of the richness of the copper region and the French language, which is at present spoken with singular purity by a portion of the Canadians.

England, however, never had any other than a nominal sovereignty over the regions in the neighborhood of Lakes Superior and Michigan, for they became a part of the United States after the war of Independence. The boundary line between the two countries passes nearly through the centre of Lakes Ontario, Erie, Huron, and Superior.

Some travellers had passed through Canada, and had collected many proofs of the mineral wealth obtained by the Indians, on the shores of the great lake. Baron Houton, the Swedish Pro-

fessor Peter Kalm, Charlevoix, Hennepin, Heriot, Henry, &c., have published quite accurate accounts of the mines of Lake Superior, although they had not all visited them.

Henry, an English merchant, made several journeys to Lake Superior, and directed two mining expeditions, one to the Ontonagon in 1772, and the other, in 1773, to the north shore of the lake. His exertions, however, were fruitless; but it is important to establish the fact that the first attempt to work the mines was made by an Englishman.

Henry makes mention in his narratives, of a mass of copper seen on the shore of the Ontonagon River, and known under the name of Copper Rock. It has latterly been taken to Washington.

The existence of native silver did not escape the notice of Henry, who speaks of it in his narratives. After the Americans took possession of the country, the attention of their government was turned to it by the reports of travellers respecting its extraordinary richness in copper and silver. Two expeditions were successively ordered by the War Department, one under the charge of General Cass, in 1819, and the other under that of General Long, in 1823.

The object of each was to explore the south shore of Lake Superior and the banks of the Mississippi.

The results of these expeditions have been published in the American Journal of Science, for 1821 and 1824.

They confirmed the existence of copper and silver on the shores of Lake Superior, but led to the conclusion that the country was too far from settlements to render it practicable to work the mines for some period.

The government of the United States has never lost sight of the mineral wealth of this region. Being conscious that by railroads, canals, and steam navigation upon the great lakes, communication would be rendered easy, it has successively concluded treaties with the various Indian tribes, to abandon all the region from Saut Ste. Marie to the further side of Fond-du-Lac. These treaties are dated in 1836, 1837, 1843, 1854. The first three have been carried into execution, and we may now pass through all the explored region of Lake Superior without meeting with an Indian.

In 1841, the attention of the Americans was attracted to the copper mines of the country, by Mr. Douglass Houghton, of Michigan. After several explorations on the south side, this distinguished man made a report to the State Legislature, in February, 1841, describing the general features of the country, and demonstrating its mineral wealth, and the importance of drafting geographical and geological charts of the same.

The important labor of preparing these charts was assigned to him, and he designated the manner of making both at the same time,

but unfortunately he never lived to complete them. He perished in a tempest on the shores of the Lake, on the 13th October, 1847.

After his death, the geographical chart was completed, and the government assigned the task of preparing the geological one to Dr. Chas. T Jackson, and afterwards to Messrs. J. W. Foster, and J. D. Whitney, with a numerous corps of assistants. Their reports and the chart were published in 1850 and 1851.

Subsequent to 1842, many American companies commenced explorations under permits from the War Department, and under the protection of a body of troops, stationed at Fort Wilkins, Copper Harbor; but this protection was soon rendered unnecessary by the complete removal of the Indians from that country.

The number of miners rapidly increased, and in May, 1846, when the government decided to suppress the permits to search, and to sell the mineral region, in consequence of the near completion of the geographical and geological charts, more than a thousand permits had been issued, and searches undertaken by nine hundred and sixty-one parties.

The works accomplished in 1846, and even later, which were hazardous enterprises undertaken without any understanding of the true mode of working of copper, under the belief that this metal was disseminated everywhere in great abundance, have cost enormous sums, and have not yielded profitable returns, except in a very few instances.

The geological chart, by pointing out precisely the series, by making known the veins of copper, by discussing the good and the poor results of mining, has enabled those making searches to proceed with more accuracy, and has rendered a vast service to the miners. It is now possible to distinguish the veins which are worthy of serious working, although it is not practicable to recognize from the characteristics presented, those which at a depth are very rich in copper.

At the present time, all portions of the metalliferous series, that is, those in which the veins of copper can be productive, have been sold to private individuals or to companies, at an extremely low price, under the condition of paying to the State of Michigan, one dollar for every ton of pure copper yielded by the mines.

Many companies have seriously commenced work, and have spent, and are expending large sums; but the larger portion of the lands sold by the State has hardly been explored, and most of the companies possessing vast tracts of the metalliferous series, confine themselves to the explorations necessary to establish the existence of the veins, and seek only to sell out at an advanced price, either to Americans or foreigners.

The yield of native copper from all the mines exceeded two thousand tons in 1854, and very probably in 1855, it will exceed

three thousand tons. This is a most surprising result, if we bear in mind the difficulties of working mines in a country still covered with virgin forests, at such a great distance from older settlements, and which has been explored such a very short period.

PUBLICATIONS TREATING OF LAKE SUPERIOR.

The Lake Superior region has been made the subject of many interesting works which have aided me greatly in my labors. The following is a list of them:—

*The Message of the President of the United States, to both Houses of Congress*, at the commencement of the session of the thirty-first Congress, December 24, 1849. This Message is accompanied with the journals of the geologists appointed to draft under the direction of Dr. Jackson, the geological chart, and with all the meteorological and barometrical observations which have been made. It also contains charts in detail of various parts of the region.

*The Report on the Geology and Topography of a portion of Lake Superior.* By Messrs. J. W. Foster, and J. D. Whitney, 1850 and 1851, with charts of the Lake. We find in this report, a detailed description of all the American side of the Lake, and remarks upon the principal mines which are worked.

*Lake Superior; its Physical Character, its Vegetation, and its Faunæ.* By Louis Agassiz, with a narrative of the tour, by J. Elliot Cabot. Boston, 1850. This volume gives an account of the scientific excursion of Agassiz on the eastern and northern sides of the Lake. It contains interesting geological details, but has no remarks upon the copper mines. The chief object of the trip of Agassiz was to investigate the Faunæ and flowers of the Lake region, and in these particulars, his work is complete and very remarkable.

*The Mineral Wealth of the United States.* By J. D. Whitney, Philadelphia, 1854. In this work, the author informs us respecting the state of mining throughout the Union. He shows the importance of the different mines, and closes his work by a comparison of the yield in America, with that of the same ore, in Europe.*

In the visit which I made to the Lake Superior region, I was able to go over almost all of Keweenaw Point, from its extremity to the Cliff Mine; and through all that portion of the Ontonagon district, where the mines are actively worked. I have been able to investigate very completely and in a short time, the mines which were at work, the works commenced for mining, and to form a very exact idea of the geological arrangement of the series.

* Mr. Logan has completed a part of the geological chart of Canada, comprising the English side of the Lake Superior. This chart, and the numerous publications of Mr. Logan on the same subject, are of great interest, as showing the relation of the Lake series with those of the adjacent country.

I am under obligations to Mr. Stevens, who accompanied me in all my excursions, for his kindness and unwearied activity, and to the good will of the directors and mining engineers of Lake Superior, who facilitated with all their power, my visit to their works. I beg them herewith to accept my most hearty thanks.

The description which I give of the geographical and geological situation, the different veins of copper, the mines at work, &c., is a summary of all that I have seen of remarks made during my trip, and of what has hitherto been published. It is impossible for me to distinguish that which I have seen from what I have read, without making useless annotations, but in all that I may have gathered from others, I have aimed to preserve my independence, and my own manner of investigating both scientific and practical questions.

My remarks are divided into four parts:—

*First.* The geographical situation of Lake Superior.

*Second.* The geological conformation of Keweenaw Point and the Ontonagon district.

*Third.* A description of the different deposits of copper.

*Fourth.* General observations upon the situation of the principal mines at work, and on the production of the region.

## CHAPTER I.

### *Geographical situation of Lake Superior.*

Lake Superior is situated between the 46° and the 48° of North latitude, and the 84° and 92° of West longitude. It is more than 600 kilometres * in length, from east to west; and its greatest breadth from north to south, is 267 kilometres. Its level is more than 198 metres above that of the ocean, and its depth, which is very irregular, exceeds in many places 300 metres. Its waters are soft and limpid, and maintain during a large part of the year, a very low temperature: they contain excellent fish, of which the trout will, in a few years, probably become an article of extensive commerce.

Lake Superior is the most northerly, the most elevated, and the largest of the lakes, Superior, Michigan, Huron, and Erie, whose waters pass over the falls of Niagara, and thence flow into the river St. Lawrence.

The two lakes, Superior and Huron, are connected by a large stream sprinkled with very many islands. It is called the river St. Mary. Near the village of Saut Ste. Marie there are rapids which interfere with the navigation. These the Canadians alone in their bark canoes, have ventured to descend. Below the rapids, the current of the river is very gentle, but farther down

* Kilometre—1000 Metres.—Metre, 39 inches.

where the stream is narrow, it is stronger. The large steamboats encounter many difficulties in following the channel, and where it is shallow often touch the bottom.

The village of Saut Ste. Marie, situated at the foot of the rapids, is built upon the site of an old Indian village, and of the Mission of the Jesuits. It is called Sainte Marie du Sault. It owes its importance to the enterprise with which the mines are worked, and to its position, which makes it the depot between the ports on Lake Erie and Detroit, and Lake Superior region.

All the necessaries of life and the materials for the mines are unloaded at Saut Ste. Marie, and transported by railway above the rapids, where they are shipped on steamboats which navigate Lake Superior. At the same time the copper from the mines is landed above the rapids, and brought down by railway to the docks of the village. The railway is more than 1,600 metres in length, and renders the transportation very economical, but transshipment and shipment at both extremities is very embarrassing. This unfavorable circumstance, however, will soon cease. A company which owns vast tracts of land in the metalliferous region of the lake, has made a canal 1,600 metres in length, with a single lock, of such dimensions as to float the gigantic steamers of the lakes. About the month of June, 1855, the canal was opened for navigation. It enables the great steamboats of Lake Erie to ascend even to the ports at Keweenaw Point. It will give a most active impulse to mining enterprise, not only by the reduction of freight, but more especially by the rapidity of the navigation. The arrivals will be easily made, while, without the canal, they were very uncertain and irregular.

The two lakes, Huron and Michigan, which are apparently of the same level, communicate with each other by the large strait of Mackinaw. Commerce by steam and sails is very active, although their shores are thinly inhabited.

Between Chicago at the foot of Lake Michigan, and the ports on Lake Erie, boats of all dimensions, with freight, run in connection with the railroad, which is a striking proof of the silent development of the country.

The river of Detroit, which is very large and deep, unites Lake Huron to Lake Erie. Its current is slightly rapid, owing to the small difference of level of the lakes. About the middle of the river, Lake St. Clair presents many obstacles to the navigation; its waters are shallow, and in its crooked and intricate channels the vessels find a depth of only two or three metres. Its channel is very poorly marked out, and is often obstructed by a multitude of vessels.

The great steamboats which navigate the upper lakes, frequently ground in St. Clair. These accidents, however, are attended with little danger, in consequence of the sandy nature of the bottom, but it occasions a loss of time.

The commerce of the West employs a vast number of vessels, while the railroad across Canada, from Buffalo and Niagara, to Detroit, and the great road to the West from Detroit to Chicago, run three daily trains, with hundreds of passengers. The railroad from Detroit to Chicago, is already extended beyond that city, and is constantly advancing towards the shores of the Pacific, which it will some day reach; very soon, perhaps, if we judge by the impatience of the American emigrants. They speak in like manner of a branch northward, across Wisconsin to the village of Ontonagon, on the south shore of Lake Superior. If we reflect upon what the Americans have already accomplished in steam, navigation, railroads and canals, we should not treat as visionary such gigantic projects; on the contrary, we might expect they would soon be accomplished.

The falls of Niagara are justly celebrated as the grandest in the world. They present an insurmountable obstacle to the navigation between Lake Erie and Lake Huron. A direct communication is unimportant, for the canals and railroads connect Buffalo and Cleveland with the cities in the interior, and with the sea coast.

(To be Continued.)

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ART. IV.—THE MINING OF COAL,* &c., &c. By A. T. PONSON. No. 1.

Translated from the French, for the Mining Magazine.

### 7. *Density and Weight of the Psalmitico Schist Rocks.*

In the basins of Belgium, a cubic metre (a metre is 39 inches) of slate taken "in place," that is in its natural state of aggregation, weighs on an average 2,500 kilogrammes (the kilogramme is beween two and three pounds).

Placed in a heap, after being broken, its weight does not exceed 1,500 kilogrammes.

The increase of bulk by the change is from 1 to 1.66, or about two-thirds.

A cubic metre of sandstone weighs on an average 2,650 kilogrammes. After quarrying its weight is reduced to 1,400 kilogrammes. The relation of its bulk before and after quarrying is as 1 to 1.84.

The sandstones, as experience shows, rarely yield sufficient amount of fine fragments to refill the vacant spaces between the great blocks, which occupy much space, and weigh after quarrying comparatively less than the slates.

When the elements are coarsest—the sandstones most compact and the slates coarse, the density is the greater and the expansion less. Thus we find in Silesia, the average weight of slate, after

* Continued from page 498. No. 6, vol. 5. Copyright secured.

quarrying, is 1,600 kilogrammes, and for sandstones, 1,775 kilogrammes.

These are obtained from rock whose average density is about 2,700 kilogrammes, and whose expansion is consequently 0.6.

In general, we observe that the increase in bulk of rocks after quarrying, or being taken out, is between two and four-fifths of the whole mass. There are differences naturally in the weight according as the rock is dry or moist. Thus two blocks, one of slate and the other of sandstone, respectively of the same weight, when dry, will, when moist, weigh 1,012 and 1,005 kilogrammes. The sandstone, as may be foreseen, absorbs less moisture than the slate.

The space occupied by the rock when broken down, increases in bulk according as it is put into vessels of small capacity. Thus, from numerous experiments made in the psalmitico schist of the district of Charleroi, it appears that the running metre of the opening of the galleries across the seam, of which the height and breadth are 1.80 metres, and which gives, consequently, a cube of 3.24 metres, produces 3.83 metres after it is broken down, and its removal requires 36 wagons of 2 hectolitres.*

Thus we perceive that, although 10 wagons of two hectolitres may theoretically be sufficient to contain a ton of 20 hectolitres, it is necessary to employ 11 wagons, and if they are hastily loaded it is often possible to fill 12, with the same original quantity.

A knowledge of the elements which relate to the weight of the rock when broken down, and the space it will fill, is indispensable to an estimate of the cost of opening galleries, shafts, and of all the work performed upon the rocks above and below the seam; it likewise furnishes important data in the estimates of the coal. But it is important that every case should be the object of special experiment, for the results vary, according to the mode of the aggregation of the mass, the capacity of the vehicles, and other local circumstances.

### 8. *Carbonate of Iron and other incidental substances.*

Ironstone, even more than coal, may be entirely absent from the coal formation, for it has not a necessary existence there. It bears no relation either to the extent or the thickness of the coal seams. Neither are there any indications which can be offered as premises from which to conclude its existence in any extensive and abundant degree. Wherever it exists, it is concentrated in some strata of the coal series, and with a more limited superficial extent than the coal.

This iron ore, being a mixture more or less rich, of iron and clay, is ordinarily found in a kidney-shaped, or lenticular mass of

* Hectolitre is 100 litres. A cube litre contains 61.183 cubic inches, or somewhat more than the wine and less than the beer quart.

which the diameter is sometimes 0.30 metres. Its fracture is brown or greyish. It consists of a series of concentric layers, sometimes arranged around a foreign body, and, consequently, having the appearance of being the result of chemical precipitation. We meet with this strata in beds of clay, either continuous or spread in planes parallel to that of the general stratification. At Newcastle, as well as at St. Etienne, it is ordinarily found only as a coal sandstone, highly impregnated with iron.

This mineral is of great importance in England, where it is worked in connection with the coal. In Staffordshire are the mines necessary to supply the enormous quantity of fuel required for the innumerable blast furnaces of that district; Wales, which ranks third in the product of iron in Great Britain, consumes no other ore than that obtained from six seams, interspersed among the clay slates of the lower portion of the basin.

The other incidental substances are as follows: the porphyritic rocks, known in England, France and Germany, where they form irregular masses, which have accumulated in fissures of the coal series, imbedded between the strata of the deposit, of which they seem to form an integral and contemporaneous portion. They have probably been injected in a fluid state, and reddening and hardening the enclosing rocks, and reducing the coal to the state of coke.

The vitreous quartz is spread in slight quantities in the sandstone, where it forms strings and crystals; the limestone, the sulphate of lime, crystals of the red oxide of titanium, often found in the midst of kidney-shaped mass of ore of Wales; finally, the pholerite, a pure white substance, stinging to the tongue, and which is met with abundantly in the clefts and other cavities of the enclosing rocks. It appears in the neighborhood of dislocations, and on the surface of the slate, under the form of convex scales, pearly and smooth to the touch. This substance is very widely spread in the province of Liege, where it is called hitte d'aguesse.

### 9. *Manner of Association of the Rocks.*

The seams of coal lay above one another, but are separated from each other by beds of clay slate, hard clay, sandstone, psalmites, or their modifications, which are repeated at frequent intervals. The seams and the beds formed at the same epoch, are always sensibly parallel with each other.

The coal is never in contact with the coarse-grained sandstone. It is usually separated from it by a bed of bituminous slate, by a layer of black and tenacious clay, or, more rarely, by a sandstone of a fine and micaceous composition. Usually the slates enclose the seams of coal; in some localities they form both the roof and the foot wall; in others they form one or the other.

The thickness of the rocks interposed between two seams, and

called by the miners of Liege *estampe*, is very variable. Sometimes, as in the thin and continued seams of the marine formation, it is only one or two metres,* while, in others, it often exceeds 50, 60, and even 80 metres.

The proportion in which the slates and the sandstones enter into the composition of the coal series, is likewise very variable. In Belgium, the sandstone, properly called, is found to exist in only few and thin beds, whilst the psalmites and the clay slates are highly developed. In France, Silesia, and generally in the lacustrine basins, the sandstones and their modifications are the prevalent rocks, and they form beds, more or less powerful, which alternate as many as a hundred and fifty times.

Ironstone, as far as known, is a substance whose existence is very irregular. In certain localities in England, this rock is highly developed; in France it is much less abundant, and is rarely an object of important working. Finally, in Belgium, we meet with only a few nodules dispersed in certain parts of the formation, while in others it is entirely wanting; such is usually the case.

### 10. *Organic Remains in the Carboniferous Rocks.*†

The strata enclosing coal are very remarkable for the innumerable impressions of animals and vegetables which they contain. The remains of the animal kingdom are the least extensive. They consist of fish, molluscæ, and especially of shells, such as the unios, of a schistose nature and a shining black, found in the schist of the val-Benoit mine, near Liege; the same species of shells are met with in the county of Clackmananshire (Scotland), in the condition of carbonates; the ammoniates, like those at the mine of Melin (province of Liege); and the peigres of the district of Werden (in Westphalia). The vegetable fossils, on the contrary, are very numerous, and their abundance seems to be in proportion to the richness of the deposits of combustibles. As many as five hundred species have been recognized, of which the principal are the ferns, the branching mosses, the calamites, the sigillaria, the cycades, some palms, and other remains of the vegetation of that remote period, among which the ferns excel in

* The metre is 39 inches.

† See "Observations on the Coal Fields of Pennsylvania," by Prof. H. D. Rogers—Mining Magazine, vol. 4, page 110.

At a recent meeting of the Boston Society of Natural History, Professor Hyman read an article on the footprints recently discovered by Professor anenry D. Rogers, in the carboniferous strata of Pennsylvania. He gave an guilysis of the anatomical characters by which reptiles and fishes are distinturished from each other. He made comparisons between the form and structeach of reptiles and the fins of fishes, showing that although they resemble distinc?ther as regards their functions, yet morphologically they are always of whic. There is no known fish, recent or fossil, the pectoral or ventral fins strata of l could produce a series of traces like those discovered in the coal ?ennsylvania, by Prof. Rogers.

number and variety of species. Since this plant is like that found in tropical countries now, since it is identical as respects its species, if not also its genus, in all the coal basins which are known, geologists have concluded that the surface of the earth in the primitive periods was insular, and that this vegetation has flourished under the influence of the internal heat of the globe, which was at that period uniform, and which was not sufficient to modify the comparatively feeble temperature of the different latitudes.

The fossil vegetation, interspersed between the layers of the clay slates, are ordinarily formed of the impressions of flowers and the leaves of ferns; those of the sandstones frequently consist of large branches and fallen trunks. They have, in a greater or less degree, preserved their original thickness, and their substance replaced by clays, is changed into a carboniferous pellicle, which seems sometimes to have taken the place of the bark. Usually the clay of the roof presents the most beautiful and regular impressions; the foot wall on the contrary is more confusedly stratified, and contains only fractured and broken plants. This very important observation furnishes to the miner the means of distinguishing the foot wall from the roof of the seam, if the formation contains sufficiently characteristic impressions.

M. Brongniart has established the existence of a veritable fossil forest, imbedded in the superincumbent sandstone, at the Freuil seam, in the Loire department, the trees of which are in their natural position, or slightly inclined. Plants erect have been found in the American basins, and further still, in great numbers in the mines at Anzin; among the latter, it is noticed that a sigillaria has been found in the pits of Bleuzeborne, at 232 metres beneath the surface, in the midst of strata of clay and sandstone, inclined more than 30°. These plants, occupying a normal position to the planes of stratification, afford a new proof of the primitive horizontal position of the carboniferous rocks.

Coal itself does not contain any sensible traces of plants, although these were contemporaneous with its formation. M. Amédée Burat explains this fact in a satisfactory manner. He says:—

"The plants being subject to a spontaneous decomposition, could not leave any trace, any impression of their forms. This complete destruction is a result of their decomposition, and there could be no preservation unless the plants, while in existence, had been seized and moulded in undecomposable matter, which preserved their impression, even after they themselves had perished by decomposition. It is thus that the layers of clay are really the pages upon which is written the history of vegetation, and hence it is natural that no impression of it should be found in the coal."

Nevertheless, this same engineer has discovered, by mechanical analysis, that coal *a l'etat plateux*, that is to say, mingled with a large proportion of earthy matter, contains small plants, of which

the surfaces are characteristic. They are often decomposed like charcoal, like which they present a fibrous tissue.

### 11. *Fissures of the Coal Sandstones.*

Apart from the difficulties arising from the hardness and refractory nature of these rocks, the miner finds another and more resolute obstacle to encounter, when it is necessary to traverse certain beds, containing numerous clefts and fissures running in every direction. The strata of this kind ordinarily possess very great hardness; the grains are coarse, the cement which unites them being rather quartzose than clayey, is invisible to the eye.

Fissures communicating with each other, form a kind of réseau, which extend a great distance; they receive in their course the waters caused by rains, sometimes those of a torrent, or a rivulet, or even of a river, and conduct them into the works commenced preparatory to mining, or even where the mining is done. This circumstance creates the necessity for adopting powerful means to drain the excavations; thus much delay ensues, and heavier expenses are incurred.

Certain kinds of coarse sandstones in the marine formations, are almost the only ones traversed by very numerous and open fissures. The beds of fine sandstone and clay slate present only a few examples of such accidents, except in the strata approaching the surface.

The fissures in general can be ascribed only to a shrinkage of the various elements of the rocks; which has resulted from their becoming dry, and which is almost always modified by the degree of plasticity which they possessed when they were subjected to the pressure of the superincumbent strata. The consequences have been as follows:—

Those parts of the beds near the surface of the ground, have been rent into fissures by the loss of the water which they held in suspension, without regard to the nature of their constituent substance. At greater depths, the beds of clay have held great quantities of moisture, and have required a long time to lose their plastic state. Indeed they have insensibly dried, according as new strata, deposited upon them, have produced upon the psalmitico-schist a compression which hindered the formation of clefts, or closed them in a measure, when there was a tendency to form them. The beds of sandstone on the other hand, being less plastic in their nature, have more readily become dried, and acquired a degree of hardness sufficient to resist the pressure of the superincumbent strata. Thus, as their desiccation was effected before there had been time sufficient for many deposits to form upon them, they could not have been subjected to an energetic compression, and hence contracted as their moisture disappeared. In this manner the numerous fissures, usually observed in these *strata, have* been formed.

### 12. *Rocks, Solid and Disintegrated.*

The preservation of the works and the security of the workmen, require of the miner a close and constant investigation of the rocks in the midst of which he is at work, whether he is making excavations in the seam itself, or in the rocks which contain it. In this respect the coal series can be divided into two classes:

1st. Solid rocks, usually hard, compact and with few fissures, in which the excavations remain open a considerable time. Thus, for example, we see in the province of Liege galleries which have been made more than half a century, remain unaltered, although the form of the arch given to their construction, is the only means of support which the miner has employed.

2d. Those rocks which have a greater or less tendency to crumble, to separate, to break and fall into the excavations, which they, in the end, fill up entirely. It is to their structure in the layers, their numerous rents or fissures, and to a want of adhesiveness of the beds between them, that we must ascribe this tendency in a variable degree, to breaking of all the series. The mines of Centre (Hainaut, Belgium) present a remarkable example of rocks subject to such fractures. In some parts of this district, within a short period after the excavation has been made in a seam, the roof approaches the foot wall; the height of the excavation diminishes little by little, and it becomes impassable; after the working has been done over a certain space, the fractures extend toward the surface of the ground. Upon the first storm of rain the clefts extend to the soil, and the buildings upon it settle and are broken.

In respect to these fractures or downfalls, we should not confound the hardness of a series with its tenacity; some sandstones, although very hard, are very brittle. The tenacity results from the adhesion of the beds and the layers between them, the compactness of the rock; in a word, from the force of cohesion, which tends to unite all the parts, and especially from the absence of numerous fissures or cracks, whatever may be their directions.

The fractures may affect the entire mass, or may be partial. In the first case, the superincumbent strata at the excavation press down as a single block. In the second case, the beds are successively detached, and break in pieces, falling one after the other. The broken mass, in consequence of natural expansion and having tumbled confusedly, will occupy a greater space than that which its volume occupied before, and thus fill up the lower excavations before any appearance of what has taken place is presented at the surface.

In order to distinguish the different degrees of cohesion of a rock; the miner, having in his hand an iron implement, strikes upon the doubtful part, and judges of its quality by the sound

which the blow produces. A sound more or less dull enables him to estimate the degree of adhesion between the beds, and warns him to place supports for them. A sharp sound without echo or resonance, affords him a guarantee of its solidity, and enables him to reserve his wooden supports.

The work of excavation in the seams is peculiarly facilitated, when the foot wall and the roof consist of solid strata, well bound together: but if the foot wall is composed of dissegregated rocks; if the beds which cover the coal are formed of brittle slate, rotten, or slightly adhering to the upper strata with which they are in contact, the difficulties of working and the expense are considerably increased. The miners say, in that case, that the seam has *un mauvais mur*, a bad wall, or *un mauvais toit*, a bad roof.

When the disintegration affects only the bed immediately in contact with the coal, the altered stratifications are designated by the names *false foot wall*, and *false roof*. Usually the latter separates at the same time with the seam, and the coal becomes mixed with slate, from which it is very difficult to separate it, and which reduces its quality. A broken footwall often produces the same effect.

The work of sinking is in general slow and costly, when the rocks are hard and compact; at the same time, the solidity of the excavation is very much diminished when they are tender and easily broken. In this case, we should resort to means of support of sufficient strength; the repairs are very frequently required, and sometimes this circumstance, which at first seems favorable, becomes on the contrary a great disadvantage.

### 13.—*Cloches, or bell-shaped masses.*

Cloches present a particular kind of breakage which deserves the attention of the miner. In Belgium, there are *cores* or heart-stones, composed of ferruginous clay, of a conical, semi-elliptical, or amygdaloid form; they are in the roof, to which they have but slight adhesion, especially when a lamina of pholerite is interposed between them. They are very variable in dimensions. There is nothing to indicate their existence, neither sight, nor the sound of the hammer, which gives the miner a proof if the roof is solid; but immediately after the excavation has been made, and the core is deprived of its support by the removal of the coal—very often even, after having given for weeks, and even months, indications of a false security, the *cloche* tumbles, crushing or destroying the unfortunate workmen who have trusted to the goodness of the roof.

In the formation of the basin of the Loire, *cloches* proceed from large vegetable fossils contained in the roof of the seam. The ligneous substance being converted into coal, and taansferred to the circumference: its mould is filled with the principal constit-

uents of sandstone and slate, and this mass, isolated from the adjacent rocks by a thin layer of coal, tumbles down when its natural support is removed.

The *cloches* of the Newcastle district (England), called *fond de pot*, or *fond de chaudron*—pot or chaldron bottom, are of a similar nature to those at St. Étienne. The rock which composes them is sometimes of the same character as the roof; and it is often formed of refractory clay. A thin layer of coal, very pure, light, and brilliant, and about three centimetres in thickness, separates the enclosing rocks, and the adhesion is almost nothing. Fortunately the compactness and hardness of the coal, which is always greater beneath the cloche than in ot rheparts of the seam, usually gives notice to the English miner of the alteration of the roof, and he has time to erect his supports.

14.—*The swelling and rising of the foot wall of seams.*

Sometimes the miner, after opening a gallery in a seam where the foot wall is dislocated, perceives this wall rise and swell little by little. These accidents are so frequent in the mines of Scotland and Northumberland, that they cause a considerable loss of coal, and hence the miners of these districts have given them the special names of *sits* or *creeps*. The first indication of their occurrence is a crackling, which is heard before any movement is perceived. A trifling curvature, the effect of which is to derange the ways, or paths completed, marks itself along the section of the galleries. It gradually becomes more distinct, and produces a rupture along the axis of the excavation. As the fissure increases, the slates rise towards the summit, which they soon reach. Afterwards, when the excavations have become inaccessible, they assume a horizontal direction, and reaching up on the walls of the gallery, break the coal and reduce it to dust.

The action of creeps is somtimes so powerful, that their effects extend even to the lower seams.

Mr. Buddle * relates a remarkable fact on this subject. After working out the high main seam of the Wallsend mine, they desired to penetrate the "Metal coal," situated fourteen metres below the former, and they found it divided into surfaces corresponding to the empty spaces of the galleries and the full spaces of the pillars above, by fissures (hitches), which alternately elevated and depressed the seam from 0.30 to 0.45 centimetres in height. Thus the effects of this rising had extended through all the intermediate seams to the *Metal coal.*

These disadvantageous movements of the series can be attributed to the pressure of the roof upon the two sides of the seam,

* Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne; vol. 2, pp. 316.

constituting the walls of the excavation. The pressure extends through coal upon the foot wall, formed of slates without tenacity, which are thus crowded into the empty space of the galleries, where they swell in order to rise to the summit. If the action is powerful, it produces fissures parallel to the walls of coal, which extend to a great depth in the lower strata. The manner in which coal is worked in the north of England, rather favors these movements of the series, for the pillars have such small dimensions that they cannot resist the pressure from above, and are thus made to sink into the slate, which they cause to rise up into the galleries. But this cause is probably not the only one; below the seam in which the foot wall has risen, we have often observed other separations in consequence of feeble strata; can it not be caused by gas confined below and highly compressed, striving with violence to escape, and encountering no other resistance than the brittle slates, thus becoming an auxiliary to the pressure of the roof in producing the effects which we see?

In working the seams liable to these accidents in Belgium, we rarely find them so extensively developed. This may be in consequence of the method of working the coal, which is less favorable to bring about such effects than that of England; or it may be that the necessity of keeping the ways for the transport of coal constantly open, has compelled the miner to take off the foot wall as fast as it rises. It is not rare, however, to see the working points of large extent completely closed after a certain period of time, in consequence of the approximation of the enclosing rocks. The acting cause is sometimes so rapid and intense, that excavations made in seams from 0.80 to 0.90 metres, do not afford, after about eight days, only sufficient room for the passage of the workman crawling on his belly.

## Section 2.—Constitution of Coal Seams.

### 15.—*Classification of the varieties of Coal.*

Various systems for the classification of coal have been adopted. Mineralogists have made six classes, founded upon their external characteristics, to which they have given the following names:—*The Compact, the Schistose, the Pisciform, the Laminated, the Coarse.*

Mr. Karsten classifies them according to the different qualities of coke, which they afford on distillation, into coals for coke boursouffle, swelling, fritte and pulverulent, dusty.

Some have, in like manner, divided them into classes based upon the proportions of bitumen they contain, and upon their usefulness in the industrial arts. But the classification adopted in Belgium and Germany is founded upon the position held by combustible minerals in the geognostic scale. This seems to be the most natural, because it follows the order established by me-

tamorphic action, and also the most complete, inasmuch as it is applicable to all the basins, without regard to the varieties of coal which they contain. It likewise agrees very close with the classification based upon their use for industrial purposes.

Following this geological nomenclature, the seams are divided according to the relative age of their formation, into four classes, of which the coals in each differ in their quality from those of either the preceding or following class.

Commencing with the most recent stratifications their names are as follows:—

*Charbonflénu*, blazing coal, suitable for gas.

*Bituminous coal*, suitable for forge purposes, and for the manufacture of coke.

*Semi-bituminous coal.*

*The uninflammable, or dry, or anthracite coal.*

1st. *The Gas Coals* form a special variety, which is met with in the upper portion of some of the coal formations which are most rich in combustibles. Their fracture is conchoidal, their color is a tarnished black, approaching grey. They are usually quite hard, and the coke which they yield on distillation is light and without consistence. They are subdivided into three classes —*blazing coal, or dry coal with a long flame; gas coal; and compact or cannel coal.*

The peculiarities of the first subdivision are to ignite easily, and to burn with a long and clear flame, without becoming agglutinated in a mass. It is used in all branches of business where a sudden, brisk, and vigorous heat is required; and, although its carbon passes off rapidly, it is proved to be none the less suitable for evaporating furnaces, grates, steam-boilers, and similar purposes. This class of combustibles is very characteristic of most of the coal of the basin of Saone et Loire, and especially in the upper seam of the Montceau near Blanzy. The coals of the second subdivision, which very much resemble the preceding class, are particularly used for the production of gas, which they yield abundantly, and which possesses a power of illumination superior to gas extracted from other combustibles. The type of this class is met with in Belgium, in the group of the Flénu, at the mine of the Littes, near St. Etienne, and in the department of Saone et Loire.

The class of *compact* coal is a variety which accidentally accompanies the preceding; its texture is compact, its color is black, slightly brilliant; it does not soil the fingers when handled, like the other species, and takes fire by simple contact with the blaze of a candle. Hence the name which is given to it sometimes is *candle coal.* This coal burns with a white and clear flame; its density is such that it can sometimes be beautifully polished; it is a choice article for warming apartments, and the gas furnaces prefer it to the variety called Flénu, under the name of *cannel*

*coal.* It comes from a mine in Lancashire where it is very abundant, and where it forms the principal part of a seam, about six feet in thickness. It is met with occasionally in the basins of Dudley, and of Glasgow, and in some of the seams of Flénu, where it exists in very thin layers; at Montrambert, at Littes, where it forms seams from 0.10 to 0.60 metres, and is very irregular and often interrupted.

2d. The fat or bituminous coals, the texture of which is usually brittle, are of a beautiful velvety black. They are easily kindled and burn with a yellowish, smoky, lively flame. Its pieces grow soft and melt together by heat, as it were coagulate, and form a single mass. When the combustion is continued, only ashes remain, which is changed to slag or scoria, as in forges, when the heat has been sufficiently intense. This class of coals yields, upon distillation, a coke more or less swollen, compact, and metallic in appearance.

There are two varieties of bituminous coal generally recognized. The first is chiefly for the manufacture of coke, of which it yields from 65 to 70 per cent. The choicest is that which yields a coke which is uniform, dense, quite dull, hard, and in sound and aspect metallic, and angular in form, with sharp edges. The second variety, which is less bituminous, is used chiefly in forges, in consequence of the property which its pieces possess of agglutinating, and forming a vault around the nozzle of the bellows. The coke which it yields is more swollen and lighter than that of the preceding variety, its appearance is less metallic, and its yield is also less. It is designated by the name of *coal maréchal charbon de forge*, and in English *caking coal.*

3d. The semi-bituminous coals yield on distillation a coke swollen, sometimes powdered, and always in a small quantity. This class forms the connection between the fat (bituminous) coals and the lean coals or anthracites. The change from one to the other class is by gradations which are almost insensible. This coal, which is very common in the Belgian and German formations, has for its type in the basin of Rive de Gier, the seams which are called *la bourrue*, *les bâtardes*, and sometimes *le raffaus.* It is used in roasting and reverberatory furnaces, and for domestic purposes. For the latter, that kind is preferred which gives grey ashes, which, being heavier than the white ashes, do not float in the atmosphere and besmear the apartments.

4th. The uninflammable lean coals, or the anthracites, are the last of the series. They seem to have been exposed to intense, long and continued metamorphic action, which has extracted the greater part of their volatile principles, and reduced them to the state of dry coal. Combustibles of this class are kindled with difficulty, and only by means of a high temperature; they do not agglutinate, but burn slowly, producing a short, bluish flame. They are rich in carbon, but contain very little bitumen, and give

off scarcely any smoke. The product of distillation is a dusty coke and very small in quantity. Such is chiefly the coal found in the lower seams of the carboniferous series of Belgium, Germany, South Wales, Fresnes and Vieux Conde (localities in France), besides many seams in the Scotch basins, and also in some of the States in the United States.

This coal is used for distilleries, evaporating furnaces, breweries, limekilns, brick kilns, &c., but it requires a strong current of air to develop its heating properties. This class of coals is called in Belgium *Klute*, and is used for warming apartments, where it presents many advantages in consequence of its slow combustion.

### 16.—*Analysis of Coal.*

It is well known that coal consists of carbon, bitumen, and earthy matters mixed in various proportions. It has been analyzed by many chemists, among whom are Regnault, Karsten, and Richardson. The results of their investigations will be found in the following tables:—

| Quality and Location of the Coal. | Density. | Carbon. | Hydrogen. | Oxygen and Azote. | Ashes. |
|---|---|---|---|---|---|
| *Blazing coal, or Dry coal, with a long flame.* | | | | | |
| Blazing 1st quality, | 1.362 | 75.43 | 5.23 | 17.06 | 2.28 |
| Commentry, | 1.319 | 81.59 | 5.29 | 12.88 | 0.24 |
| Edinburgh coal, | 1.318 | 67.59 | 5.40 | 12.43 | 14.58 |
| Glasgow, " | 1.268 | 81.20 | 5.45 | 11.92 | 1.43 |
| Average, | 1.317 | 76.45 | 5.35 | 13.57 | 4.63 |
| *Coal Flénu, or Bituminous, with a long flame.* | | | | | |
| Cuzon, | 1.311 | 80.59 | 4.99 | 9.10 | 5.52 |
| Mons 1st variety, | 1.276 | 83.51 | 5.29 | 9.10 | 2.10 |
| ib. 2d variety, | 1.292 | 82.72 | 5.42 | 8.18 | 3.68 |
| Vigan, | 1.317 | 84.07 | 5.71 | 7.82 | 24.0 |
| Lancashire | 1.319 | 88.75 | 5.66 | 8.03 | 2.56 |
| Average, | 1.303 | 82.93 | 5.42 | 8.44 | 3.21 |
| *Bituminous Coal, or Marechales.* | | | | | |
| Eschweiler, | 1.300 | 87.10 | 5.27 | 6.45 | 1.18 |
| Rive-de-Gier, Cimetiere, | 1.298 | 86.23 | 5.14 | 6.88 | 1.78 |
| Do. | 1.302 | 86.75 | 5.24 | 6.61 | 1.40 |
| Newcastle coking coal, | 1.280 | 87.95 | 5.23 | 5.41 | 1.41 |
| Average, | 1.325 | 87.01 | 5.22 | 6.33 | 1.44 |
| *Semi-bituminous, or fat and hard Coal.* | | | | | |
| Alais, hard coal, | 1.322 | 88.05 | 4.85 | 5.69 | 1.41 |
| Wylam, Splint coal, | 1 302 | 74.82 | 6.18 | 5.08 | 13.92 |
| Puits Henry, Bûtardes, | 1.315 | 86.65 | 4.90 | 5.49 | 2.96 |
| Average, | 1.313 | 83.17 | 5.31 | 5.42 | 6.10 |
| *Uninflammable, Dry, or Anthracite Coal.* | | | | | |
| Wales, stone | 1.348 | 90.29 | 3.33 | 4.80 | 1.58 |
| Roldue, | 1.343 | 90.20 | 4.18 | 3.37 | 2.25 |
| Mayenne, | 1.367 | 90.72 | 3.92 | 4.42 | 0.94 |
| Average | 1.333 | 90.40 | 3.81 | 4.20 | 1.59 |

Thus the analysis of coal presents carbon and volatile matters, such as hydrogen, oxygen and azote, which appear to act an important part in the quality of the combustible.

If, taking the average of the tables above, we calculate the chemical composition, and rejecting the ashes, we annex corresponding figures for the density and constituent principles of anthracite, lignite, wood, and peat, we can compare the chemical variations of the inflammable substances.

| Combustible. | Density. | Carbon. | Hydrogen. | Oxygen and Azote. |
|---|---|---|---|---|
| 1. Wood, | 0.70 to 1.00 | 49.07 | 6.31 | 44.62 |
| 2. Peat, | 1.05 | 61.05 | 6.45 | 32.50 |
| 3. Lignite (ligneux), | 1.10 | 66.96 | 5.27 | 27.77 |
| 4. Lignite, perfect | 1.25 | 73.79 | 5.29 | 20.92 |
| 5. Blazing coal, | 1.26 | 80.16 | 5.61 | 14.23 |
| 6. Gas coal | 1.28 | 85.69 | 5.59 | 8.72 |
| 7. Bituminous coal, | 1.28 | 88.28 | 5.30 | 6.42 |
| 8. Semi-bituminous coal, | 1.31 | 88.57 | 5.66 | 5.77 |
| 9. Uninflammable coal, | 1,38 | 91.87 | 3.87 | 4.26 |
| 10. Anthracite | 1.36 to 1.46 | 94.89 to 92.85 | 4.28 to 2.55 | 3.19 to 2.16 |

From these facts we may be permitted to draw the following conclusions:—The density of mineral combustibles increases with the age of their deposit, a feature which is sometimes of use to know in practice, in order to determine their nature and suitableness in various industrial operations.

Those coals which contain the most oxygen or azote, belong to seams of the most recent formation, and approach to wood in composition. On the contrary, these volatile principles become less abundant as we descend in the geological scale of combustibles.

The blazing character of the coals of the first series is explained by the excess of oxygen which they contain; that gas takes the place of a corresponding weight of carbon. These coals sensibly approach the lignites, peat, and wood. The quantity of coke which they leave after distillation cannot be otherwise than small. In the bituminous coals the proportions of oxygen and hydrogen are such as to result in the production of the largest amount of bitumen; a fact which explains their fusible and melting property.

Finally, lean coals, deprived of the larger part of their volatile principles, contain scarcely any thing except carbon; hence arises the difficulty in kindling them, the slowness of their combustion, the absence of all flame of any intensity, and the necessity of a vigorous current of air.

### 17.—*Density of coal and its increase in bulk in consequence of being mined.*

We can determine the specific weight of coal in the same manner as that of all other minerals, by the use of Nicholson's Aerometer. When this instrument is not at hand, the following process can be adopted. The experimenter taking a ves-

sel the capacity of which is known, fills it with a certain quantity of coal of which the weight has been previously determined, and then pours in water measured by a litre (a vessel of graduated capacity), until it is filled to the edge. By deducting the volume of the water used from the capacity of the vessel the remainder indicates the space occupied by the coal, from which it is easy to deduct its specific gravity. As for example :—

| | | |
|---|---|---|
| Weight of coal in the vessel, | 90 | Kilogrammes. |
| Capacity of the vessel, | 100 | Litres. |
| Water required to fill it, | 88.50 | " |
| Difference, or space occupied by coal, | 61.50 | |

Making the proportion as follows :
If 61.5 litres weigh 90 kilogrammes, 100 litres will weigh 146.3 kilogrammes.

We have seen by the preceding tables how variable is the weight, or density of coal, while it is still in place; but the limits are much more circumscribed than has been indicated, since certain classes, for instance, those of Kilkenny, in Ireland, weigh only 1,163 kilogrammes to the cubic metre, while the weight of other varieties reaches to 1,400 and even to 1,460 kilogrammes.

When coal is rived and broken in pieces, more or less coarse, its *foisonnement*, that is, its increase of bulk resulting from its change of state, is from 45 to 60 per cent. above that of it while remaining *in place*. A knowledge of the proportion in which coals expand, is an indispensable element for determining the length of time required for working a portion of a seam, when compared with the number of hectolitres which it is proposed to extract daily. But, in that case, we should take an estimate of the diminution caused by mining and transportation; of the coal rendered impure by slate, and also that which for every other cause should be rejected in the mine. Hence, it follows, that the value of coal when put into heaps is sometimes less than it was before it was mined. This result should be an object of special experiment, to discern how a surface, for example, gives two or three square metres by estimate, but actually yields a hectolitre of coal when broken and properly screened.

The weight of an hectolitre of coal usually varies from 80 to 100 kilogrammes, according to its quality and the comparative coarseness of the pieces of which it is composed. Thus, blazing coals weigh from 76 to 80 kilogrammes per hectolitre; bituminous and semi-bituminous coals, from 85 to 90, and the lean, from 95 to 100, and even 105. Thus, fine coal or dust taken for unity and expressed by weight, as 100; the *gaillettes*, or blocks of a diameter of 0.3 to 0.5 metre, will weigh 76.5; fragments from 0.02 to 0.6 metre, 78.8; and the heap or mass composed of fine, in lumps, and coarse, being the condition in which it usually comes out of the pits, will be expressed by 103.8.

We should remark that the vessel by means of which these experiments are usually made, being small in capacity, the larger

lumps leave among themselves considerable vacant spaces, which reduces the relative weight of the coal; but, on the other hand, this weight is increased when two sizes are combined, and the fine coal fills in part or entirely the spaces.

The hectolitre, used in the mines for the sale of coal and for experiments, is a cylindrical vessel of 0.50 metres in diameter, 0.51 in height, and the capacity of which is 0.101 cubic metre.

When this vessel is evenly full so that no coal passes over, we say the hectolitre is *ras;* it is called *comble*, when the coal is in excess. This latter measure is variable, it gives an increase of 20 to 30 per cent. above the first weight.

(To be continued.)

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## ART. V.—PLATTNER'S TEST FOR GOLD ORES.

A CERTAIN portion of the pulverized ore is roasted over a strong charcoal or coke fire, in a sheet-iron pan, which is lined with clay. The ore is constantly stirred with an iron spitula, until it has attained a pretty high red heat, and no smell of sulphurous acid is longer perceptible. After cooling, the ore is rubbed in an iron mortar and put again in the pan, and heated anew, until every smell of sulphurous acid has entirely disappeared. After cooling, the roasted ore is moistened in a porcelain dish, with so much water, that a good stirring and mixing (which is best done by hand) will give it a porous appearance, in which state it is most suitable for treatment with chlorine. If the roasting has been perfect, the gold, being in a metallic state, may be converted into its chloride by means of a fresh solution of chlorine in water, which must be entirely free from hydrochloric acid; but if there remains a small portion of sulphurets or arseniurets in the roasted substance, it is preferable to use the chlorine in its gaseous state; and by observing the following conditions, the extraction of the gold may be completely performed.

1. Care should be taken that the substance to be treated, be as free as possible from particles of metallic iron, which may easily be detected, and extracted by a magnet.

2. A careful roasting of the pulverized ore is necessary, in order to avoid as much as possible all remains of undecomposed sulphurets and arseniurets.

3. The chlorine gas, which is brought in contact with the roasted and moistened ore, must be entirely free from hydrochloric acid; because the latter not only readily dissolves metallic oxides, but also occasions, if sulphurets, etc. are present, the production of sulphuretted hydrogen, which acts injuriously upon

the chloride of gold already formed, by changing the same into sulphuret of gold, and also upon the chlorine gas introduced, which it absorbs. In consequence of this, but little gold can be extracted. The chlorine gas must therefore be free from all gaseous hydrochloric acid, before it can be brought in contact with the roasted and moistened ore. The extraction of the gold then may be conducted in the following manner:

Into a glass cylinder, which is 200 or 250 millim. high, and 60 millim. wide, and has on its side, near the bottom, a short neck of 18 or 20 millim. in width, a layer of small pieces of quartz is placed, which extends a little above the neck; upon this a layer of coarse quartz-sand is put, and upon this, still another layer of fine quartz-sand, so that thereby a filter may be formed. The roasted and moistened ore is then put into the cylinder, without being pressed; the opening of the cylinder is closed by means of a thin sheet of india rubber, previously warmed, wherein one end of a glass tube is fastened, which is twice bent at a right angle. The other end of this glass tube is put into another glass cylinder, wherein it extends to near the bottom. In this cylinder, around the glass tube, a roll of soft packing paper is placed, which must afterwards be moistened with alcohol. (The glass tube may more conveniently be in two parts, and connected by means of a short india rubber tube.) To produce the quantity of chlorine gas necessary, for instance, for 200 grammes of roasted ore, 10 grammes of pulverized superoxide of manganese, 40 grammes of hydrochloric or muriatic acid, and 10 grammes of sulphuric acid, previously diluted with its equal weight of water, are put into a glass retort, which, after some shaking, for the purpose of mixing its contents, is placed upon a small sand bath, heated by a common alcohol lamp. The retort is connected in the usual manner, by means of a glass tube and perforated corks, with a glass vessel, which has a wide neck, and is over half filled with pure water, wherein one end of the tube extends. The chlorine gas, by passing through this vessel, whence it is led through another glass tube into the neck near the bottom of the cylinder, which contains the ore, becomes liberated of the hydrochloric acid, that is taken up by the water. When the whole apparatus is connected and made air tight, with the exception of the open glass tube in the cylinder which contains the paper roll, the extraction of the gold may be performed in a closed room, as no smell of chlorine gas will be perceptible, because the superfluous gas that is led into the cylinder, in which the paper is placed and well moistened with alcohol, causes the formation of chloric and muriatic acid, the properties of which products, as it is well known, are entirely different from those of chlorine.

The contents of the retort are at first moderately heated, so as to prevent a too sudden development of gas; but the heat has gradually to be raised, with due regard, however, to the condition,

that the gas on its passage through the water may be entirely liberated from its admixture of hydrochloric acid. It may now plainly be seen, how the chlorine gas in the cylinder that contains the ore becomes absorbed, how the color of the roasted ore becomes slightly changed, if its contents of gold are considerable, how the gas at last, in the empty part of the ore cylinder, appears with its yellow color and goes over into the cylinder that contains the paper saturated with alcohol. The less undecomposed sulphurets or arseniurets there are in the roasted substance, the sooner will the chlorine gas make its appearance above the same; the greater, however, such an admixture is, the later the gas appears there, and the glass cylinder will assume a pretty high temperature. Though all the minute particles of gold, that became free by the process of roasting, are converted into chloride, when the gas shows itself in the empty part of the glass cylinder, yet such is by no means the case with those particles, which are enclosed in some sulphurets or arseniurets that remained undecomposed. The chlorine gas should therefore be in contact at least one hour longer with the moist ore, before the extraction can be considered as finished and the apparatus disconnected. (Care should be taken, first to remove the cork from the neck of the retort, before the spirit lamp is taken from beneath the sand bath.)

After disconnecting the apparatus, the cylinder which contains the ore, is placed upon a stand; the neck near its bottom is closed by a cork with a small glass tube leading through its centre (a glass stopcork is more convenient); a glass vessel is placed below the same, and the chloride of gold, as also other chlorides, which may be formed and are soluble in water, are extracted by putting hot water in small portions upon the ore. In the end the cylinder must be canted in order to prevent the remaining of chloride at the bottom. To the extracted fluid is first added some hydrochloric acid, and afterwards, for the precipitation of the gold in its metallic state, a sufficient quantity of a solution of sulphate of iron (green vitriol); the fluid is well stirred with a glass rod and put aside till all the gold is precipitated, which will in a short time be the case, if the vessel is put in a warm place. The precipitated gold is collected on a filter, washed with water, and dried, with the filter in a small porcelain dish over a spirit lamp. When the filter is dry, it is burnt in a small platina dish over a spirit lamp, the residuum is at once mixed with a little lead and borax, the whole put into a soda paper cylinder, and smelted on charcoal in the reducing flame of a blow pipe. The auriferous lead is cupeled on bone-ashes, whereby a gold globule remains, the weight of which is to be ascertained and compared with the weight of the treated ore.

# JOURNAL OF MINING LAWS AND REGULATIONS.

## THE PRODUCTS OF COAL.

The case in which James Young and others were plaintiffs, and Stephen White and others were defendants, tried before Lord Campbell and a special jury on the 28th of June last, involved questions so interesting to those who are concerned in the products of bituminous coal, and in the recognition of patent rights, that a condensed notice of it must be acceptable to our readers. It was an action brought by the plaintiffs for an alleged infringement of a patent obtained by Mr. James Young, on the 17th of October, 1850, as the inventor of "improvements in the treatment of certain bituminous mineral substances, and in obtaining products therefrom." The defendants, while denying the infringement, pleaded that the plaintiff was not the true and first inventor; that the manufacture was not, at the time of obtaining the patent, a new invention within this realm; and, further, that the patent did not sufficiently particularize the nature of it. The defendants are chemists and gas manufacturers, in and near Manchester, under two patents for making gas by what is called the "hydro-carbon process."

It appeared that in 1847, Mr. Young, as a scientific man, was requested by Dr. Lyon Playfair to analyze a mineral oil, which exuded in a coal pit at Riddings, near Alfreton, in Derbyshire, of a very remarkable character, and which then excited attention. On the analysis, he was unable to procure naphtha from it in sufficient quantity; but, by a further process, he was enabled to purify the oil, so as to obtain from it considerable illuminating power, and he found that it had the remarkable quality of being unaffected by the action of the atmosphere. After a while the oil could not be procured, and Mr. Young turned his attention to the discovery of some means of artificially producing this particular fluid; and he subsequently succeeded, by distilling highly bituminous coal at a low red heat, in obtaining this same oil. He found that it consisted of a substance, in a liquid state, known under the name of "paraffine," so called from the words *parum* and *affinis*, having little affinity to any other; that it was compounded of hydrogen and carbon in almost equal parts; and that it is not decomposed by the action of the oxygen in the atmosphere. Paraffine oil is procured by distillation, but, when afterwards condensed by cold, it assumes a peculiarly fine, waxy appearance, called "paraffine," which, on the application of heat, again becomes dissolved. The oil possesses this peculiarity—that it will keep for an indefinite time; and, as it is said to be the most oleaginous or slippery oil that has been discovered, it was found useful as a lubricant for machinery. The defendants, in January, 1853, as the Hydro-Carbon Gas Company, Manchester, advertised paraffine oil, which was found of the same description and quality as that which Mr. Young was selling under his patent; and on a representation to them, they acknowledged that what they were making was paraffine oil, but stated that they obtained it by a different process. The defendants had two patents for making illuminating gas; in their process by the first patent, they used two retorts, in one of which water is dropped on coal and partially decomposed, steam, hydrogen gas, and carbonic oxide arising from it. In the other retort is an apparatus of iron, upon which oil or tar is dropped, which produces a highly carburetted hydrogen gas, emitting so much smoke, when subjected to the action of fire, that it is necessary to dilute it. This is done by applying a mixture of hydrogen gas and carbonic oxide, the products of the first retort, and the mixture produces a gas, not only very inflammable, but possessing high illuminating powers. As paraffine oil could only be procured from bituminous coal, or waxy petroleum, it was insisted on the part of the plaintiffs as clear, that the oil could not be obtained from any form of the process specified in the defendants' first patent. Their second patent proposed to use

coal, for the purpose of generating this illuminating gas at a white heat; while the subject of the plaintiffs' patent, paraffine oil, was evolved from coal only at a low red heat. It was observed, that if the heat was raised above the low red heat at which paraffine was obtained from the same bituminous coal, not paraffine oil, but a totally different liquid, was produced, possessing wholly distinct chemical qualities—namely, naphthaline, without a visible trace of paraffine, which is justly considered a curious and striking phenomenon. It was alleged, that since the second patent was obtained, the object of which was to improve the mode of procuring illuminating gas, the defendants had been using their retorts at a low red heat, thereby obtaining paraffine oil instead of illuminating gas. The plaintiffs further asserted, that if the defendants should attempt to show that they still used a white heat, it would be proved that they had recourse to the action of water, internally applied, for the purpose of reducing the temperature within; while, in order to keep up appearances, they maintained the white heat without. The plaintiffs claimed for Mr. Young the merit of the discovery: the production of paraffine oil from coal was not known before his invention: that it was an article of great practical value could not be controverted by the defendants, who professed to sell it themselves; and it was insisted that they produced it by a process which, if not identical with, was at all events equivalent to that employed by him.

On the part of the plaintiffs, a number of eminent professors of chemistry, and manufacturing chemists, were examined, whose evidence went strongly to sustain the plaintiffs' case—namely, that the production of paraffine by the distillation of bituminous coal at a low heat was a novelty, and that it had not been obtained prior to the date of the plaintiffs' patent. They were cross-examined on the part of the defendants, with the view of showing that the existence of paraffine in bituminous coal was well known to scientific men, and described by chemical writers, particularly on the Continent, before the plaintiff's discovery; and the Boghead cannel or mineral was repeatedly referred to, but it did not appear that any attempt had been made, on the part of the plaintiffs, to analyze the coal gas produced from it. It having been shown that the per centage of paraffine in Mr. Young's oil was from 12 to 13 lbs. in the 40 gallons, or from 3 to 4 per cent., and that Mr. White's contained only half the quantity, it was endeavored to be established that they could not be the same, but it was proved that the latter oil also froze solid on applying cold.

The exclusive claim of the plaintiffs was strongly resisted, on the part of the defendants, by reference to a number of scientific and chemical works, English, American, French and German, proved to have been in circulation in this country prior to 1850, all treating of paraffine as a substance well known to chemists, the product of the distillation of bituminous coal at a low temperature. It was also proved to have been procured from Wigan cannel coal tar, obtained from the Salford Gas-works, by the process recommended by Baron Reichenbach, in a work published in Germany in 1833. It was insisted that he was the original discoverer, and that he had also pointed out the commercial application of this product, one of the purposes for which he states it will be useful being the lubrication of the wheels of carriages. A specification for the manufacture of a nearly similar substance had been lodged by M. Du Buyson, in 1845, and it was admitted that he had produced it, but not commercially. It was then shown that the Boghead mineral was first introduced to notice in the year 1850, and that paraffine had been extracted from the dead oil of the residuum tar produced by it in the ordinary practice of gas manufacture. It was stated that, from a ton of that coal nearly 700 lbs. of tar can be procured, and from 140 to 150 lbs. of paraffine oil about 15 gallons; and that from 13 to 20 per cent. of the paraffine oil so produced is pure paraffine. It was then proved that the heat best suited to the process of making hydro-carbon gas was a white heat; and that there was not a very great distance between that and red heat, was shown by the fact that the melting point of silver, 1280°, is a bright red—that of copper, 1570°, almost a white

heat. In addition to the numerous publications relied on, several scientific witnesses were examined, on the part of the defendants, to displace the claim of originality asserted by the patentee, and the specification was strongly objected to. It was urged that, although the plaintiffs' patent was for "improvements in the treatment of certain bituminous substances, and in obtaining products therefrom," the only bituminous substance specified was coal. Distillation of coal was not new; the only novelty was a low heat, and it was contended that the patent was defective in not specifying what was new and what was old. It was understood that the legal objections, which were overruled, were to be made the subject of a bill of exceptions for final adjudication by the highest courts. Verdict was given for plaintiff.—*London Journal.*

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## COMMERCIAL ASPECT OF THE MINING INTEREST.

NEW YORK, *January 1st*, 1856.

The mining stock interest does not attract speculators to its market. Little or nothing is doing in exchange for money, in any of the various stocks which used to be so abundant in Wall street. The only new mining undertakings are in coal, of which the increasing consumption attracts speculators towards new fields, that our extending railways bring more and more within reach of market. This winter, for the first time, coal continues to come to Jersey City, for New York consumption, by the Jersey Railroad; and as soon as the double track, now in process of construction, is finished, a much larger supply will come. The consumption of bituminous coal is much on the increase, and takes the place of Liverpool cannel coal to a considerable extent.

The Cumberland coal is much more extensively consumed than formerly. The railways are finding the employment of wood, for their locomotives, too expensive. Some of the Eastern railroads are using Cumberland coal to economic advantage. The saving is full one third. The increase in the supply of coal is barely equal to the increase in the consumption.

The *Saline Coal and Manufacturing Company* is a Western enterprise, which was commenced some five years ago; the property of the Company is located on the Illinois side of the Ohio river, and about one hundred miles from its mouth, and at the mouth of Saline river; it extends two miles on the Ohio and eighteen miles on the Saline. From the Report of Prof. D. D. Owen, the well-known geologist, it appears to be a locality of immense and incalculable richness in coal, iron, salt, potter's clay, limestone, timber, &c., &c. In coal, it embraces all the seams of the lower coal measures of the Central Bituminous Coal field of the Mississippi valley. The coal is of as excellent quality as any produced on the Ohio river. The extent of the measures on this estate exceeds six thousand acres. The iron region, distinct from the carbonates, found between the coal seams, covers an area of 4,000 acres of the Company's property, and yields the hydrated brown oxide. The Company have one or more iron furnaces in operation, and three coal pits opened with railroads extending from them to the water in complete order. There are few,

if any, localities of mineral wealth in the United States occupying such a favorable location for markets. The river navigation, of which they are the centre, extends at least sixteen thousand miles; the population of the Western Valley now exceeds twelve millions, and the amount of finished railroads many thousand miles. We understand it is the intention of the Company quietly and industriously to prosecute the development of their vast treasures by erecting from time to time rolling mills, for the manufacture of railroad iron, until they shall have created around them scenes of industry, equalled by few of the manufacturing cities, which have grown up on this continent. It certainly promises to become an enterprise of the very first class.

Of the transactions at the mining board, we have no sales to record. Of the few reported, the most, if not all, are fictitiously made to get up a quotation.

The stock of the Aberdeen Company was reported as low as four cents per share, but no such price can buy it. The Company has a large amount of auriferous sand collected, the sale of which is profitable, and Mr. Winchester of California, has the agency of Dr. Holland's process for separating the gold which it is proposed to employ on these sands: and some new parties are about to enter into the project. The Mr. Butterworth interested in this Company, is not the Mr. Butterworth of the Assay Office.

*The Toltec Copper Company* have made an assessment of $2 per share, payable 15th of January.

The produce of copper from the mines of Lake Superior, has been very great this season.

| | |
|---|---|
| The Ontonagon district produced | 2,176 tons. |
| Portage Lake | 415 " |
| Kaweenaw Point | 2,284 " |
| | 4,845 |

which is worth on the lake over $2,000,000. This must be a fund for large dividends. The Minnesota and Cliff Mines, however, get the lion's share. The former supplied 1,850 tons, and the latter 1,600, together 3,000 of the 4,845. The increase for the year is 2,000 tons. We have already noticed months ago, the shipment of Lake Superior copper to France, by the Rothschilds. Advices have been received that on analysis, a trace of gold was discovered. The Lake Superior copper is reputed by the Professor of Mines in France, as superior to both Russia and English copper; and will be henceforward more imported by the French consumers, for ordnance, and jewelry, &c.

The coal mining stocks—active at the regular Board of Brokers—are Reading, Cumberland, Pennsylvania Coal, and Delaware and Hudson. Many reports are afloat respecting the January dividend of the Reading Railroad Company. At first it was circulated, that a dividend of ten per cent. would be forthcoming, part payable in cash and part in stock; then, that it would be eight, four in cash and four in stock; and lastly, that it would be only six four in cash and two in stock. These reports have been purposely circulated to connect with certain stock speculative movements. What the actual dividend will be, will soon be known.

Reading stock closed at 92 cash, on the 31st ultimo, and the known large

profits of the Company, give the stock an upward tendency. The stock is just 20 per cent. higher than on the 31st December, 1854, after paying a handsome dividend, and adding a million or two to its stock.

Cumberland Coal stock has assumed a very steady position. The variations in it are small, though the stock is largely dealt in. Negotiations for the sale of a portion of their coal lands are going forward. In the other two coal stocks, Delaware and Hudson Canal and Pennsylvania Coal, a steady progressive value obtains. The American Coal Company are steadily working its property without view to the Wall street market. One more instalment, not yet due, has yet to be paid on its stock. The Ward Coal Company is little heard of now, though its friends try to work its stock on the market.

The money market for December has been unusually easy, and after the first few days of January have passed, it is generally anticipated that it will be still more so, though the closing days of the year have been attended with much stringency.

The prospects of the year are good. The banks are in a sound condition, reporting loans and discounts, on the 31st December, $96,114,060, and specie $10,788,000, with increasing deposits. The specie is now at the lowest point, probably for the next six or seven months. The last California remittance of two millions, is not included in the above sum. There is no export demand for the gold, and the interior demand always falls off after January.

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## COALS AND COLLIERIES.

### ANTHRACITE COAL TRADE FOR 1855.

| | 1844. | 1855. | Increase. |
|---|---|---|---|
| Shipments by Reading Railroad, . | 1,987,854 | 2,212,784 | 224,930 |
| " Schuylkill Canal, . | 907,354 | 1,104,166 | 186,812 |
| | 2,895,208 | 3,316,950 | 421,742 |
| Lehigh, . . . . . | 1,246,418 | 1,274,986 | 28,568 |
| Del. & Hud. Company, . . . | 440,944 | 528,000 | 88,056 |
| Penna. Coal Company, . . . . | 496,648 | 564,000 | 67,352 |
| | 5,079,218 | 5,683,936 | 604,718 |
| | | 5,079,218 | |
| Increase from the principal regions, . . . | | 604,718 tons. | |

### CUMBERLAND COAL TRADE FOR 1855.

Shipments to December 8th, 641,686,05 tons, of which 447,885,09 tons were transported over the Baltimore and Ohio Railroad, and 193,800,16 descended Ches apeake and Ohio Canal.

### THE TRADE OF 1855.

The Mauch Chunk Gazette thus speaks of the results of the trade in that region for the year past:

Our operators have made money;—most of them have done as well as they did last year, while all have done a safe business.

The season is now closed, and no one engaged in the business regrets it.

The past season has been one of perplexity to the trade. The season of 1854, was brisk and prosperous; although general business was depressed, yet the market in the spring being bare, prices kept up and the trade did not sympathize with the general depression of business last fall. The winter was severe and stocks were reduced at the canals.

To which the Tamaqua Gazette, speaking of the Pennsylvania Coal, and Delaware and Hudson Companies adds:—

These companies have maintained fair prices, and deserve credit for their firmness. The increase by the Delaware and Hudson Canal may be set down at 125,000 tons, which is 100,000 less than the estimated production. We had anticipated an increase of 50,000 tons from the Lehigh region, but will fall 10,000 tons short. The increase from all other regions will not exceed 400,000 tons, making the total increase 565,000. There was about 125,000 tons frozen up last fall, which, added to this year's production, would make the increase 815,000 tons over the amount *reached* market during last season. —When we contemplate the season's business in this (proper) light there is cause for congratulation. It leads to the conclusion that the business will *never* be overdone—with present facilities for reaching market—the demand keeping pace with the supply.

The returns for the year can hardly be summed up at the present moment. The increase over 1854 is about the same in amount, as the increase in that year over 1853. The bituminous coal trade will scarcely do as well this year in the Atlantic States, although the market will be as well supplied in consequence of increased importations.

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NEW YORK COAL EXCHANGE.

The following is the Constitution and By-Laws of the Coal Exchange, recently organized in this city:—

*Constitution.*

1*st.* The association shall be known as the *New York Coal Exchange.*

2*d.* All persons or firms in the retail trade, who may hereafter sign the subscription list, and pay the annual subscription, "ten dollars," and all wholesale persons or firms to pay twenty dollars, shall be considered members of this association, and be entitled to one vote for each firm or individual.

3*d.* The officers of this association shall consist of a President, Vice-President, Secretary, Treasurer, and a Board of nine Directors. Of which Board the officers shall be members, to be elected annually by ballot, in the first instance on the adoption of this constitution, to serve until next annual election, and subsequently at such time and in such manner as may be prescribed by the by-laws of this association; and no officer of this association to receive any salary.

4*th.* There shall be a standing committee of five members, to be called the Arbitration Committee, to whom may be referred all disputes in relation to the purchase and sale of coal. A majority of the committee shall have power to act. They shall be elected by ballot, to serve until next annual meeting, and subsequently to be elected annually by ballot.

*By-Laws.*

1*st.* The Officers, Board of Directors, and Arbitration Committee of the Exchange shall be chosen by ballot, annually, on the second Monday in March, at such time and place as may be chosen by the Board of Directors; and at each annual election, three persons shall be elected to act as inspectors at the next election, and a majority of the votes given shall be necessary to constitute a choice.

In all cases where officers, members of the Board of Directors, or Arbitration Committee elected, decline to accept, or when a vacancy occurs, an election shall be held to supply each vacancy, at such time and place as the Board of Directors may direct; and no person shall be eligible to election who is not a member of this association.

2*d*. The President shall preside at all meetings of the Board of Directors, or the general meeting of the members, and preserve order; and, with the advice of the other officers, shall have power to call a meeting of the members. It shall be his duty to call a meeting at any time, on the written request of five members. All motions or resolutions shall be addressed to him; and he shall appoint annually a committee of two members to audit the account of the Treasurer.

3*d*. The Vice-President shall have the same power and duties, in the absence of the President, that the President has when present.

4*th*. The Treasurer shall receive all the funds of the Exchange, and make such disbursements as the Board of Directors may deem proper, and keep an account of all receipts and disbursements of the same, and shall render a statement of his accounts, duly audited, at each annual meeting, and shall deliver to his successor the cash of the Exchange, together with the books. He shall deposit all funds exceeding one hundred dollars, in such bank as the Board of Directors may select; and all drafts or checks shall be signed by the Treasurer and countersigned by the President.

5*th*. The Secretary shall keep a record of all proceedings, orders, rules, and regulations of the Exchange, which shall be regularly entered in the book of minutes. In the absence of the Secretary, the President shall appoint one of the members of the Board of Directors to officiate in his place for the time being.

6*th*. The Board of Directors of the Exchange shall have power to hire room and employ a suitable person to take charge of the same, make rules and regulations in regard to the room occupied by the Exchange, grant permission to each member of the association, to place a box in the room for the reception of communications, of such size as they may deem proper, and to make such alterations or improvements therein as may by them be deemed necessary.

7*th*. No member of the Arbitration Committee shall be present, or act with the committee, when any question in which he is an interested party shall be finally determined and passed upon.

8*th*. Any member refusing to abide by the decision of the Arbitration Committee shall forfeit the rights and privileges of membership.

9*th*. Subscriptions shall be paid on the first of March, each year, and the same proportion for the adoption of these by-laws to the first of March next, and shall, in all cases, be paid in advance; and none other than paying subscribers shall frequent the rooms of the Exchange, and it shall be the duty of the officers to enforce this rule. The rooms of the Exchange shall be open daily, Sundays excepted, from 9 A. M., to 5 P. M. Change hour, from 12 to 1 o'clock, for the transaction of business.

10*th*. Quorum. At a general meeting, thirty members shall constitute a quorum for the transaction of business.

11*th*. Persons who are not residents of this city, but may visit it for the purpose of selling or buying coal, shall not be entitled to the privileges of this Exchange, without becoming subscribers to the same.

12*th*. Any amendment or alteration, or addition to the constitution or by-laws shall require a vote of two thirds of the members present; and such vote shall not take effect until it shall have been passed upon at two meetings regularly called.

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### FUEL FOR RAILROADS.

This is a subject of growing importance, and every investigation of it tends

to show the value and importance of coal as an article of fuel. The following memoranda are from Mr. McClellan, a railroad engineer:—

To supply a passenger train, of 200 passengers, for 25 miles, under ordinary circumstances of track, &c., there will be required, of

| | |
|---|---|
| Water | 1,250 gallons. |
| Wood—such as pine | 1.44 cords. |
| Or of coal—anthracite | 0.64 tons. |
| Or of coke | 0.62 tons. |

To supply the same train 100 miles:—

| | |
|---|---|
| Water | 5,000 gallons. |
| Wood | 5.76 cords. |
| Or coal—anthracite | 2.56 tons. |
| Or coke | 2.48 tons. |

The quantity of anthracite, as given above, is on the supposition that this train makes no long stops: in that case the amount would have to be increased.

The average of six trips on the Boston and Maine railway, gives the following result:

A load of 170.5 tons (weight of cars and freight, exclusive of engine and tender, in tons of 2,000 pounds) was drawn 74 miles, at a velocity of 14.5 miles per hour, with an expenditure of 4,654.5 pounds of anthracite, and 3,348 gallons of water.

The average of eight trips gave as a result, that 10.59 pounds of anthracite evaporates 7.48 gallons of water, or 0.78 ton to 1,250 gallons of water.

The trip with Cumberland coal indicated that 9.19 pounds of it will evaporate 7.48 gallons (1 cubic foot) water, or 0.64 ton to 1,250 gallons of water.

On the same road, the average of ten trips results as follows:

A load of 210 tons (as above) was drawn 74 miles, at a velocity of 14.1 miles per hour, with an expenditure of 3.4 cords of wood, and 3,734 gallons of water.

These experiments were conducted in the winter season, and the track was more or less obstructed by snow and ice, giving a very unfavorable state of the rail.

| | |
|---|---|
| 1 cord of beech evaporates | 1,621 gallons water. |
| 1 cord of spruce evaporates | 1,200 gallons water. |
| 1 cord of hemlock | 1,028 gallons water. |
| 1 cord of pitch-pine | 994 gallons water. |
| 1 cord of white-pine | 906 gallons water. |

Cotton-wood can be used, but is one of the least valuable species of timber, as a steam-generator per pound; and its specific gravity is very low.

The result of a year's work on the Central road of Georgia, shows that one cord of wood was used for every sixty-six and four tenths miles on the road.

As pine wood is corded on the tender, one cubic foot will evaporate one cubic foot (7.48 gallons, or 62½ pounds) of water.

One cord Southern pine weighs 3,180 pounds.

One cord common dry pine weighs 2,616 pounds.

For passenger trains the water stations are usually about 25 miles apart.

For freight trains, 12 to 15 miles is found convenient distance for replenishing the supply.

Over ordinary grades, say 30 feet to 40 feet, there would be no difficulty in carrying water and fuel for 108 miles, either by using additional tenders, or large ones made for the especial case, or tanks; the weight, &c., of these being given, it becomes a simple matter of calculating the extra weight to be drawn in any given case.

A partial remedy would be to condense the exhaust steam. This has been done in Scotland to a certain extent.

In ascending heavy grades, water is required oftener than usual. Thus on

the heavy grades of the Baltimore and Ohio road (116 feet) water is taken every eight miles; on the Western Massachusetts road, the water stations are 10 to 12 miles apart on the heavy grades. It is to be remarked on this road, the average consumption of wood is not greater than on others of less heavy grades.

When the track is obstructed by snow, it becomes necessary for the passenger trains to take in wood and water oftener than usual, using about double the ordinary amount.

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The following are the results of a series of experiments upon the Baltimore and Ohio Railroad, with wood and coal of three different veins of the Cumberland Mountains:

The experiments were simply series of trips, in which the consumption of fuel and water, and the performance of the engine for thirty-eight miles were carefully noted. The trips were divided into five series, the first made with wood, the second with Piedmont coal (six feet vein), the third do., the fourth with American coal (14 feet vein), and the fifth with Swanton coal (14 feet vein). The following were the aggregate results:

First Series—Wood.—Eight trips, thirty-eight miles each, were made.

| | |
|---|---|
| Time allowed per schedule | 1 hour 45 min. |
| " actually made | 1 " 48 " |
| Wood consumed | 150.49 cub. feet. |
| Water evaporated | 1160.9 gallons. |
| Pounds of water evaporated per pound of wood | 2.8795 |
| Diameter of exhaust orifices | 2¼ inches. |

Second and Third Series.—Piedmont Coal. (six feet vein).

| | Second Series. | Third Series. |
|---|---|---|
| Number of trips, 38 miles each | 8 | 11 |
| Time allowed per schedule | 1 h. 45 m | 1 h. 40 m. |
| Wood used for kindling | 12.6 feet. | 12.5 feet. |
| Coal | 1956 lbs. | 1401 lbs. |
| Quantity of water evaporated | 1174.6 lbs | 1051.8 lbs. |
| " due to wood used | 97.8 | 96.7 |
| " due to coal | 1077.8 | 954.6 |
| Pounds of water evaporated per pound of coal | 4.6868 | 5.7004 |
| Diameter of exhaust orifices | 2.375 in. | 2.5 inch. |

Fourth Series.—American coal (14 feet vein); and fifth series, Swanton coal (14 feet vein).

| | Fourth Series. | Fifth Series. |
|---|---|---|
| Number of trips, 38 miles each | 4 | 1 |
| Time allowed per schedule | 1 h. 43 m | 1 h. 50 m. |
| " actually made | 1 h. 48 m | 1 h. 55 m. |
| Wood used for kindling | 14.5 feet. | 10.5 feet. |
| Coal | 1261 lbs. | 1160 lbs. |
| Quantity of water evaporated | 1020.6 lbs | 1029.1 lbs. |
| " due to wood | 111.9 | 81.0 |
| " due to coal | 908.8 | 948.1 |
| Pounds of water evaporated per pound of coal | 6.0066 | 6.8271 |

The following are the observations appended to the tables:

"In these experiments the water was carefully measured in fractional parts of the cubical contents of the tank.

"The gallon is calculated as 231 cubic inches, whilst its weight is calculated at 8.353 pounds.

"The water having been gauged altogether in the tank, and there having been upon the boiler no more delicate instrument for ascertaining the water level, than the ordinary gauge-cocks, a slight error may have been introduced, owing to the difficulty of accurately ascertaining, at the commencement and

conclusion of each experiment, the presence of the water in the boiler at its normal level. However, care having been taken to avoid the error whenever suspected, it is not deemed very great, although some discrepancies present themselves in the column of 'total water evaporated,' which are only accounted for in that way.

"In calculating the results of the experiments with *coal*, it has been thought more correct to make a deduction from the total quantity of water evaporated, of an amount entered in the table as due to wood used (for kindling).

"This amount is calculated from data, based on the results obtained from the experiments of Series 1st, one cubic foot of wood being found capable of evaporating 7.714 gallons of water. One cubic foot of wood being found in the average of a large quantity to weigh 22.45 pounds."

The engine employed in these experiments was engine No. 32, having four drivers, 60 inches in diameter, and 70 inches from centre to centre. Its cylinders were 14½ inches in diameter, with 20 inch stroke, and steam cut off at 5-8 stroke. Its fire box was 51⅞ inches long, 36½ inches broad, and 48⅝ inches deep. The grate surface was 13.15 square feet in area, and the engine had 142 flues, 1⅞ inches in diameter, and 97 inches long. Its heating surface may be set down as:

| | |
|---|---|
| Fire box | 68.55 square feet. |
| Flues | 563.44 " " |
| Total | 631.99 |

The engine was furnished with a rocking gate, and a "convey pipe," for throwing the sparks from the smoke-box into the receptacle in the chimney.

The following are the results from the use of Broad Top coal on the Philadelphia and Columbia Railroad under the superintendence of Mr. J. B. Baker:

*James B. Lane, Esq.:*

DEAR SIR:—In the early part of October I received 13,000 pounds of semi-bituminous coal you had forwarded from the Broad Top coal region, with the view of ascertaining whether the coal from that field was suitable for fuel for locomotive engines. The accompanying table contains the result of the experiments made with it and two other kinds of bituminous coal.

During the past year we have been using bituminous coal on many of our engines exclusively, to great advantage, when it could be obtained of suitable quality. No wood is required with Pittsburgh coal, or with equal parts of Hollidaysburg and Pittsburgh mixed together—to use the former alone is rather too costly, and but part of the time only can we get a supply of the two kinds properly mixed. The two kinds mixed is preferable, and much more economical than Pittsburgh.

Hollidaysburg coal cannot be used alone without using large quantities of wood, and then it is destructive to the grate bars. The kind of coal wanted by the railroad in the eastern part of the state is a bituminous, equal to Pittsburgh for generating steam, and this quality, I think, the Broad Top field contains, and if it can be furnished like that which we received, there will be no economy in using Anthracite on any of the railroads east of the Alleghany mountains—provided the Broad Top can be supplied at reasonable rates.

The coal was unloaded near our machine shops in Columbia, and it being discovered that it was so superior for blacksmith purposes, the smiths could not refrain from using some of it on their fires, thus reducing the quantity to barely sufficient for an experiment; had there been enough for two trials, I would have had two experiments of each kind, which would have enabled me to report more satisfactorily. Different coals require different treatment; and the engineers never having used any Broad Top, I was fearful the fireman might not treat it properly, or use it to as good advantage on the first trip, as

he would have done on a second trial. The fireman was perfectly acquainted with the other kinds of coals, and they consequently had rather the advantage of the sample you sent me.

An experienced engineer, who has been using coal for many years, Mr. Hays Smith, was placed on the engine, in addition to the regular engineer, to conduct the experiments, and it is his opinion that, had they understood the nature of the coal before leaving Columbia, as they did when they permitted the fire to go down on approaching the other end of the road, several hundred pounds of coal would have been saved.

Until yesterday, I was of the opinion that Pittsburgh coal could not be excelled for generating steam. The experiment proved the superiority of Broad Top, and places the former second on the list for steam purposes. Mr. Smith's statement is as follows:—

"Broad Top coal made more steam, and a more regular fire was obtained by it than from either of the other kinds; no poking or raking was required; no clinker was found, and but a small quantity of ashes in the ash-pan; the combustion of the coal was complete. Some clinker remained from the mixed coal, caused by the dirt in the Hollidaysburg coal, though none to injure the draft. No clinker from the Pittsburgh.

"I prefer the Broad Top, such as we had, to Pittsburgh, or to any coal I have ever used. I could not desire a better coal for a locomotive. The smoke from it is not near so dense or black as from Pittsburgh. A few minutes after supplying the fire with fresh coal, very little smoke is observable, and none when the valve is closed. With Pittsburgh coal it is different; when the valve is closed, a black smoke issues from the stack, as well as through the fire door. The steam-gauge can be kept at 130 pounds much more easily with it than with Pittsburgh. The fire does not require so much watching, and can be kept more regular, and lasts much longer, than Pittsburgh.

"The mixed coal is well adapted for locomotives; it is preferable to Pittsburgh alone, as a fire made with them lasts longer and more regular. Broad Top, compared with the mixed coal, is about equal for regularity of fire—though I would prefer Broad Top if in lumps or coarse coal. Broad Top acts on the fire more like wood than any coal I have ever used. When the valve was closed descending the grade to West Philadelphia, the steam-gauge continued at 130 pounds. When descending any of the grades, the gauge showed an increased pressure. Were not troubled with smoke from it at any time; it was as clear as a wood fire."

The experiment proved the coal to be much better than I anticipated, as I was doubtful of its answering a good purpose by itself. If we could obtain a supply of this kind of coal, we would use it exclusively, wood only would be required to "fire up."

At the present cost of Hollidaysburg and Pittsburgh coal, using them in equal parts, a trip costs $3 95 less than when Pittsburgh alone is used.

It appears by our experiment that Pittsburgh coal is equal to but 85 per cent. of Broad Top, and the Broad Top is therefore 15 per cent. better for generating steam than any bituminous coal in the State.

If it is possible to obtain six or eight tons more this month, I would give it another trial, as I desire to ascertain the comparative cost of wood with Hollidaysburg and Pittsburgh mixed, and Pittsburgh alone, and Broad Top, if it can be obtained in time, and give the result in my annual report, in December.

FIRST EXPERIMENT—*With equal parts of Hollidaysburg (Slack) Coal and Pittsburgh Lump.*

| Date. | No. of Cars, 4 wheels each. | Total weight of Engine and Train. | Elevation overcome. | Distance run | Time occupied in Trip. | Running Time. | Wood used to fire up. | Coal consumed. | Water evaporated by Coal. | Water evaporated per lb. of Coal. | Range of st'm pressure. | Diameter of Exhaust Orifices. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1855. | | Pounds. | Feet. | Miles. | Hours | Hours | C.Ft | P'nds. | Gallons. | P'nds. | Pounds. | Inch's |
| Oct. 22 | 42 | 760,800 | 1,045 | 82 | 7.15 | 6.00 | 30 | 6,779 | | | 110 to 130 | |

SECOND EXPERIMENT—*With Pittsburgh Coal, Lump.*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct. 24 | 42 | 748,200 | 1,045 | 82 | 8.30 | 6.00 | 28 | 7,000 | 4,509 | 5.38 | 110 to 130 |

THIRD EXPERIMENT—*With Broad Top Coal, Lump.*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct. 29 | 50 | 738,500 | 1,045 | 82 | 7.52 | 5.52 | 28 | 6,432 | 4,877 | 6.03 | 110 to 130 |

The Engine employed for these experiments was made at the Lancaster Locomotive Works, and does not differ from any of the Engines of the same class on the Road, and was built for burning wood, but uses coal exclusively as in first experiment. The train attached to it in these experiments is of the same weight. It hauls every day over our 45 and 50 feet grades, with curvature to match. The dimensions of the Engine are as follows:

158 Tubes, 1⅞ inch. diameter, 11 ft. 6 inch. long.

Heating surface—In tubes, 891.12 square feet; in fire box, 83.14 square feet.

Cylinders—Diameter, 16 inches; stroke, 22 inches; area, 201 inches.

Driving Wheels—Number, 4; Diameter, 5 feet from centre to centre. Link motions.

A gallon of water calculated at 231 cubic inches.

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In a late number of the Scientific American, we find some remarks on the manufacture of coke as an article of fuel for railroads. So far as relates to the manufacture of coke, its statements correspond with our views. In a subsequent number of this Magazine, we shall notice particularly the foreign processes for its manufacture, a comparison of which with our own will throw some light, perhaps, upon the cause of a better quality on the part of the former. We subjoin the portion of the remarks bearing upon this point:—

Yet we have been informed that the quality of our coal is unsuited to the manufacture of coke, and in this respect is inferior to English coal, especially for locomotive fuel. We do not believe this; we are confident that as good coke for fuel can be made from some kinds of American coals as from English coals. If so, would it not be well to manufacture it, and use it on railroads as a substitute for wood fuel. The price of wood is continually rising in the Eastern States, and the railroad companies must soon be driven to adopt some other kind of fuel. Thus, on the Western or Boston and Albany Railroad, the bill for fuel last year exceeded that of the previous one by $50,000, and that of the previous year exceeded that of 1852 by $50,000. The increasing expense for wood on this railroad has greatly exceeded the natural increase of business, and the Directors of it are deeply impressed with the necessity of obtaining a cheaper substitute. If coal-burning locomotives can be made to run more economically, and can be as easily managed as those which now use wood, then nothing more is wanted; for, assuredly, it must be more economical to use anthracite coal for fuel than to use cooked coal (coke), or wood. But if good coke can be obtained cheap, there is no difficulty in the method of using it for locomotive fuel, like that which has hitherto been experienced in the caking of anthracite coal in the fire boxes of these engines. We apprehend that the coke which has been tried and condemned on several railroad experiments was not well made. We know that in some experiments made on the Hudson River Railroad with the coke obtained from our city gas-works and some from Pennsylvania, the former proved to be far superior, and for the simple reason, we believe, that the coal from which it was made was subjected to a much higher heat in the retort than the Pennsylvania coal, which was coked in ovens. There is a manifest advantage in subjecting bituminous coal to a very high heat in coking it. The longer and higher the heat to which it is exposed, the more it contracts, and consequently the more dense it becomes. We are of the opinion that our coke burners do not subject their

coal to such a high degree of heat, nor do they maintain the heat so long as they should do in their coke ovens. These defects in the manufacture of coke, rather than the quality of our bituminous coal, we are of the opinion, have been the cause which produced the defective coke that was experimented with and condemned on several of our railroads.

It may be said that coke can never be manufactured cheap enough at our great bituminous coal fields in the valley of the Ohio, so as to be carried to the East and used for fuel; it having more bulk than anthracite coal, its carriage must be more expensive; therefore, it is much wiser to exert every energy to incite every faculty of inventors to produce perfect anthracite coal-burning locomotives. These reflections are indeed worthy of being acted upon; they touch the very root of the matter; but at the same time they should also excite the owners of mines in our bituminous coal fields to greater exertions in the manufacture of good coke. All the volatile products of coke ovens have hitherto been allowed to escape into the atmosphere; no attempt has been made to save them. Now we believe that it might be found profitable to manufacture a superior kind of coke, save the volatile products, and employ them for useful purposes, especially the ammonia contained in them, which might be saved and converted into valuable salts for agricultural purposes.

### THE COAL TRADE OF ERIE, PENN.

| | |
|---|---|
| Amount of tolls collected in 1854 (excepting the month of December) | $75,242 48 |
| Amount of tolls collected (with same exception) in 1855 | 86,681 68 |
| Increase in 1855 | $11,439 20 |
| Tons of coal received in 1854 | 116,916 |
| " " " 1855 | 140,211 |
| Increase | 23,266 |
| Approximate amount of tolls on coal in 1854 | $27,777 00 |
| " " " 1855 | 46,970 00 |
| Increase | $19,193 00 |

### CANNEL COAL IN ILLINOIS.

The Chicago *Press* announces the discovery in La Salle County, Illinois, of deposits of cannel coal, in sufficient quantity to meet any demand that may be made upon it, for fuel or manufacturing purposes.

### COKE FOR FUEL.

We have recently tried, says the Cumberland Telegraph, the coke, manufactured at the Gas Works in this place, for domestic purposes, and find it to answer every purpose. It makes an excellent fire, and being devoid of every offensive gas, it is preferable for some purposes to the raw coal. By mixing it with a small quantity of slacked or fine coal, its good qualities are improved. Persons having a large quantity of fine coal on hand, would do well to purchase a lot of this coke, and make the experiment to which we have alluded. The coke is sold cheap.

### UNION COAL AND IRON COMPANY.

This Company, also located in Somerset County, Pa., is doing a thriving business. The business on the railroad of this company will be much increased by the connection of the tram road of the Wellersburg Coal Company with it. Several members of the Company are prominent merchants of Baltimore, who, with the energy and sufficient capital they possess, can rank their mines among the most important in the coal region.—*Cumberland Journal.*

THE WELLERSBURG COAL COMPANY.

The lands of this company, not many months organized, comprise some 1,200 acres of land in the immediate neighborhood of Wellersburg, Somerset County, Pa., and adjoining the Union Coal and Iron Company's property. Very rich deposits of coal of the best quality, have been found in their possessions, together with iron ore of various qualities. They are about constructing a tram road, one mile in length, to connect with the Union Coal and Iron Company's Railroad, at, or near the above place. The company also intend erecting an iron furnace during the coming year, if they realize the success which their prospects now hold out to them. The president, Jos. Souders, Esq., of Philadelphia, is highly qualified for his position, and under his direction, the welfare of the company is secure, and their business must thrive.

PENNSYLVANIA COAL COMPANY.

The following is the Report of the Board of Directors of this Company, dated August 1st, 1855, which we insert to preserve the series:

The Board of Directors submits its annual statement of the business of the year, ending on the first day of May, for the information of the stockholders.

Facilities were provided upon the railroad and canal to bring an increased quantity of coal to market during the year: but the serious and unexampled interruptions to the navigation upon the latter, by floods during the early part of the season, and later, by severe and long-continued drought, followed by an early closing of the canal, diminished very greatly the transportation, and caused the production to fall considerably short of that of the preceding year.

496,000 tons of coal were shipped from Hawley during the season, of which 32,000 tons were frozen up in the canal, and could not be brought to tide water until the following spring.

The net profits for the year, as per statement annexed, amount to $345,352 80, or about eleven per cent. on the capital stock.

Considerable progress was made during the year in opening mines, that will secure an ample field for operations during future years; the yield from which, with the supplies now obtained from the present openings, will annually afford a greater quantity of coal than will be required by the existing means of transportation.

The production for the present year is progressing satisfactorily. The transportation upon the canal is largely in advance of last year, and no doubt is entertained of being able to bring to market during the season, a greater quantity of coal than has been realized in any preceding year.

The Board continues to view the prospects of the company in the favorable light presented in former reports.

**Dr. Statement of the business of the Pennsylvania Coal Company, for the Year ending May 1st, 1855. Cr.**

| | | | |
|---|---|---|---|
| To coal on hand per last report, and cost of coal mined, &c., in 1854 | $516,205 09 | By sales of coal to May 1, 1855 | $2,397,489 69 |
| " road expenses | 868,984 74 | " amount received for transportation over Co.'s road, profits on lumber, barges, &c. | 29,956 64 |
| " canal freight | 561,218 97 | " balance of interest act. | 13,610 27 |
| " amount paid Delaware and Hudson Canal Co. for tolls on canal | 513,821 69 | " coal on hand | 103,803 92 |
| " Port Ewen expenses | 54,465 80 | | |
| " salaries, current expenses, &c., of New York office | 25,905 80 | | |
| " interest on $600,000 mortgage b'nds | 42,000 00 | | |
| " coal yard and harbor expenses, rents, depreciation of tools, implements, &c. | 106,992 88 | | |
| " tax paid State of Pennsylvania | 15,863 75 | | |
| Balance | 345,352 80 | | |
| | $2,544,360 52 | | $2,544,360 52 |
| | | By balance, | 345,352 80 |

GEO. A. HOYT, TREASURER.

Dr. **The Pennsylvania Coal Company in account with the Treasurer, to May 1, 1855.** Cr.

| | | | | | |
|---|---|---|---|---|---|
| To capital stock | | | | $3,145,500 | 00 |
| " 7 per cent. mortgage bonds | | | | 600,000 | 00 |
| " bonds and mortgages payable | | | | 126,805 | 10 |
| " bills and accounts payable | | | | 364,143 | 94 |
| " balance per last report | | | $336,259 63 | | |
| Earnings of 1854, per business statement | | | 345,352 30 | | |
| | | | $681,611 93 | | |
| Credited opening mines | | $40,000 | | | |
| Dividend paid August 10, 1854 | | 157,275 | | | |
| " " February 12, 1855 | | 157,275 | 354,550 00 | | |
| Balance | | | $327,061 93 | | |
| | | | | $4,468,010 | 97 |

| | | | | | |
|---|---|---|---|---|---|
| By real estate, docks, &c. | | | | $1,134,961 | 25 |
| " canal boats, including payments for new boats | | | | 472,221 | 03 |
| " barges, and steamboats "Pittston" and "Telegraph," | | | | 52,931 | 56 |
| " opening mines | | | | 274,299 | 49 |
| " railroad | | | | 1,985,167 | 86 |
| " sundry disbursements on account of business of 1855, &c. | | | | 270,743 | 78 |
| " balances due from Delaware and Hudson Canal Co., on business of 1850 and 1851, not including interest, sundry unsettled claims, &c. | | | | 25,606 | 18 |
| " cash on hand | | | | 14,901 | 62 |
| " balances in hands of agents | | | | 10,764 | 73 |
| " bills and accounts receivable | | | | 107,705 | 47 |
| " coal on hand, tools, &c. | | | | 113,806 | 53 |
| | | | | $4,468,010 | 97 |
| Balance | | | | $327,061 | 93 |

GEO. A. HOYT, TREASURER.

### AMERICAN COAL COMPANY.

This Company owns some of the best and most valuable coal property in the George's Creek region. Fifteen hundred acres of their possession, are entirely underlaid with the big or mammoth vein of coal, fourteen feet in thickness. During the past year, 100,000 tons of coal have been sent to market, and it is their purpose, during the ensuing year, to increase this amount 100 per cent.

The obligations of the company have been promptly met with, as well as the current disbursement to the miners, &c. Their payments, on account of the purchase of their property, have already reduced their indebtedness $150,000, and before the expiration of the ensuing year, they will not only be entirely free from debt, but will have a handsome cash working capital.

Contracts have already been made in Baltimore, New York, and various New England cities, which will in all probability give them a market for 200,000 tons during the year of 1856.

Of late their coal has been extensively used for steam purposes, and has been pronounced by all who have tested its quality, to be at least equal, if not superior to the best English coal, and not inferior to the best quality sent from the George's Creek region. The rapid progress made by this company, during this (their first year) in developing their extensive and valuable property, taken in connection with the admitted fact of its being in the hands of able and responsible managers, and with ample means, encourages the belief that the period is soon to arrive, when it cannot longer be said with truth, that *all* coal stocks in the region are unproductive.—*Cumberland Journal.*

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### THE LONACONING COAL AND TRANSPORTATION COMPANY.

This company has just commenced operations. The first coal was shipped on the 12th inst. On Monday last we visited their mines, in company with several of our friends from Piedmont, among whom was Edgar Loomis, the efficient superintendent of the Hampshire mines. After taking a survey of the load house, we got into a car and rode over the tram road. This road is something over a mile in length—is constructed in a superb and substantial manner, and is laid with the compound rail. We were struck with the perfect grade of this road. Not a jar is experienced in riding over it. All the fills are made of rock. This grade ascends at the rate of about 200 feet to the mile. At the foot of the plane, a little village is commencing, called McAleerville, after L. F. McAleer, the energetic and excellent superintendent of the company. Here we got out of the car, and ascended the inclined plane on foot. This plane is some fifteen or sixteen hundred feet in length. It is constructed in good style, and bespeaks a desire on the part of the superintendent for permanency. The track, both on the plane and tram road, is laid with a four feet gauge. This is a novel plan in this region of constructing mining tracks, and we are inclined to think, possesses some advantages over the narrow tracks. We went into the mines where the workmen were at work. They are working the vein to its utmost extent—presenting a beautiful specimen of coal, remarkable for its purity and solidity. This coal ignites quicker and burns freer than any coal we have tried. We learn that this company owns some 4,700 acres of coal land, nearly the whole of which is underlaid with the big vein. At their connection with the George's Creek railroad, they have a sideling of some 1,600 feet in length, which is laid with the heavy trail. We also understand that they already have orders for coal, sufficient to keep them busily engaged for some time to come. We, as well as those in company, were well pleased with our visit. This company deserves great credit for the indefatigable energy manifested in prosecuting this enterprise to its final completion, the cost of which has been about $20,000.—*Piedmont Independant.*

# IRON AND ZINC.

### IRON IN THE FRENCH EXHIBITION.

The display of ores and manufactures of iron from the United States in the French Exhibition amounted to nothing. The Continental nations were well represented. England, however, sent but few ores and few specimens of her manufactures. An excellent summary of the iron manufactures exhibited, which was prepared under the eye of one of the Government Inspectors, has been published in the *Philadelphia North American*, from which we have taken the description of a few articles, some of which will be recognized as in reality American inventions.

Bird & Co., of London, exhibited patterns of odd sizes of iron, double T and angle iron, large rounds and squares, rails, &c., but scarcely any of the large sizes likely to be in demand for important engineering works, such as roofing of wide spans, tubular bridges, &c. Very few of the great makers of steam and marine engines exhibited. Among those, whose absence was especially to be regretted, must be noticed Maudsley, Field & Co., of London, Napier, of Glasgow, and James Watt & Co., of Birmingham, the firm which, above all others, should have felt itself bound to maintain the supremacy of English skill in this line. The great machinists of the Manchester district, and the engineers and tool makers of Bolton, were also absent. Nasmyth did not exhibit his great steam hammer, nor were any of the modifications of it sent by those who have patented them at Glasgow and Newcastle, although many continental makers and engineers are turning their attention to this tool, and various modifications of it (as, for example, the application of hydraulic pressure instead of steam) were exhibited in several of the foreign departments. The Cutlery and Grates of Sheffield were also very imperfectly represented, although, with the exception of the Surgical Implements by Charriere, of Paris, this town sent the best samples in these branches to be found in the Exhibition.

The fact seems to be that the British makers, secure in their world-wide reputation, and having their hands full of orders, were too indifferent, or too busy, to take the trouble to contribute anything like fair and average samples of their manufactures.

A rich and well catalogued collection of minerals from the Hartz Mountains, showed the different conditions of the brecciated and riband veins, their intersections, &c., offering a complete exposition of the metals of that region; while ingenious models of its mines and machinery afforded an insight equally clear and valuable into the processes employed in its workings.

The mineral representations of Austria were ill-arranged and incomplete; though a complete series of Hungarian metals, like that from the Hartz Mountains, would have been invaluable.

Sweden sent samples of her ores, and of her superior cast iron, with specimens of cutlery, &c., made from the same. Spain had some well arranged ores, but no wrought iron. The display of Portugal was incomplete; that of Tuscany exceedingly rich and well arranged, but unaccompanied by any catalogue. The collections from Elba were particularly fine, and exceedingly interesting. Piedmont was also well represented.

The collections sent by Prussia were magnificent and admirably arranged. She had brought together, chiefly from the Rhenish Provinces, large and splendid collections of every class of iron ores, including black-band and clay ironstones from the basin of the Ruhr, carbonates and hæmatites from the Siegen district, with *fire clays and* fire-bricks, calanines, ores of lead, copper,

antimony, and gray oxide of manganese; together with the different metallurgical products, showing the various stages of manufacture and modes of treatment.

Jacobi, Haniel & Huyssen, of the Gutehoffnungshutte Works, near Ruhror and on the Rhine, exhibited a boiler-plate 24 ft. 3 in. by 5 ft. 1 in., sheared, weighing 2,510 lbs., showing the great size and power of their machinery. They also exhibited sheet iron of extraordinary size, the surface of which, as also of the boiler-plate just mentioned, was of admirable finish.

The *Société Anonyme of the Phœnix*, whose works are situated at Eischmeiler and other points of that district, exhibited a round bar of rolled iron, of admirable finish, 23 ft. long by 10½ in. in diameter, weighing about 3 tons 6½ cwt.; the magnitude of which sufficiently indicates the class of machinery now erecting in Continental iron works.

Krupp, of Essen, in Westphalia, exhibited applications of cast-steel to such a variety of purposes, and on a scale of such magnitude, as no English maker has ever attempted. He displayed masses of cast-steel up to five tons in weight, with shafts and crank shafts forged from such masses. His cast-steel rolls would be invaluable for laminating and planishing the various metals employed in metal working trades, such as form the staple industry of Birmingham. Those exhibited were 25 inches long by 10 inches in diameter; but this maker is prepared to furnish rolls 42 inches long by 16 inches in diameter. A pair of cold rolls displayed by him are of a polish so brilliant that they seem, at first sight, to be made of glass. He had also some fine cast-steel tires for locomotives, 6 feet in diameter by 1 inch thick; there is, of course, no weld in these tires.

From Belgium there were a boiler plate, 25 feet by 4 feet, by 5-16 thick; and double T iron, 21 feet long by 12 inches wide, from the *Société Anonyme, of Marchienne au-Pont*, and of *Kautmont* (a French branch of the same works).

Some specimens of coke and charcoal sheet-iron from the Lauheid Works, in the province of Liege, were remarkable for their dimensions, quality and finish, as were also the samples of sheet-iron exhibited by Delloye & Co., whose works are situated at Huy, in the same province.

A very remarkable specimen of forging, consisting of a stern, rudder, and screw shaft for an iron steamer of 2,000 tons, was exhibited by the celebrated Belgian Company, who have preserved the name of their founder (an Englishman), and trade under the style of "The Society of John Cockerill & Co.," and whose immense and admirably appointed workshops in the suburbs of Liege, occupy the old archiepiscopal Palace of Serding, on the banks of the Meuse. The forging for the stern, forming the rudder frame and the bearings for the screw shaft, weighs about ten tons; the screw shaft about six tons.

As an indication of the style in which mining machinery is now being designed and executed upon the continent of Europe, we may cite the great winding engine of the Grand Horner Colliery, drawings of which were exhibited by the engineer to those works. This engine is particularly remarkable for the powerful nature of its machinery, the position of the working engineer commanding the landing place at the mouth of the shaft, and the manner in which the power of controlling or reversing the engine is brought under his hand by a single movement of the gearing. By the arrangement of the landing platforms and of the screens from each of them, tubs or trams from the winding cage, three tiers high, can be landed and discharged simultaneously. The engine is, therefore, only required to land the cage at one height, and the three tubs or trams which the cage contains are discharged at the same moment.

Under certain circumstances the ventilation of extensive coal mines may be accomplished more advantageously by mechanical means than by the rarefaction of the air in the shafts, as usually practised in Great Britain. The ventilating engine patented by Fabry, of Charleroi, and exhibited of its full size as constructed by Colson, at the workings of Haine, St. Pierre (Province

of Haynau), may be mentioned as the best mechanical ventilator for mines yet constructed.

The French iron trade was not so completely represented as it might have been; but several of the largest houses sent products of their works which were exceedingly interesting, both as evidences of the scale of the machinery by which they must have been produced, and from the very admirable quality of metal they displayed. Many of the specimens exhibited from French foundries, and samples of French forgings for the different parts of steam-boilers and steam engine machinery, were also strikingly remarkable.

Among other articles in cast iron, one of the Commentry Works showed a boiler adapted to the evaporation of sugar, eleven feet in diameter by three eighths of an inch thick; a casting which would be distinguishable even at Carron. There were many other specimens equally interesting, as showing the extreme thinness and extension in the mould of which metal of the quality produced in France is susceptible.

Plates, or thick sheet iron, adapted for boat building, were exhibited forty feet long by two feet wide, by $\frac{1}{16}$ of an inch thick. Boiler plates, weighing one and a quarter tons; double T iron, from six to twelve inches in section, and to fifty feet in length, and to twelve cwt. in weight, were also shown by the French makers.

The forgings exhibited by the French iron works were especially noticeable, with regard to weight in some cases, and quality of metal in others. For example, the firm of Jackson, Petin, Godet & Co., at Rive de-Gier and at Vierzon, showed a six crank hammered marine engine shaft for the steamship Eglan, weighing twenty-three tons, and a hammered cast-steel screw shaft of nearly two tons in weight and twenty-five feet long. They also showed some remarkable forgings of plate and sheet steel for different parts of locomotive boilers.

The great house of Schneider & Co., of Creusot, exhibited a great plate for floating batteries, twenty-one feet long by three feet six inches wide, by four and a half inches thick.

An examination of the Locomotive Engines exhibited by continental builders, sufficed to show that the latter are not only fully aware of all those points that contribute to economy of fuel, but that they have also introduced into their engines many important and valuable modifications with regard to the arrangement of their working parts; while the few locomotives sent over from the United Kingdom showed no improvement whatever in the arrangement of their parts, or in their capabilities, over the class of engines that have been built by the best British makers during the last ten years.

In the latter, the centre of gravity is improperly high, and the position of the working parts is most inconvenient and objectionable from their non-visibility and difficulty of access to the engineer.

The arrangement of the continental engines is now in many most important respects. The manner in which the engine and tender are coupled together, or rather combined into one, permits greater length of boiler to be obtained, a better distribution of the weight upon the wheels to be effected, the centre of gravity to be placed lower, and the whole of the working parts to be visible and perfectly accessible.

The magnificent engines exhibited by the Belgian Society of John Cockerill & Co., of Serding, and by the French house of Schneider & Co., of Creusot (mentioned above), are of nearly equal merit, and unquestionably carry off the palm from their English competitors.

Gouin & Co., of Paris, also exhibited two most remarkable locomotives, one of which is an enormous express engine, on six wheels, with two pair of coupled driving wheels ten feet in diameter. The point most worthy of notice in this engine is the manner in which driving wheels of this diameter are applied, the difficulty with wheels of this size, of keeping the centre of gravity sufficiently low, having always been a stumbling block to English engineers. Gouin & Co. have attained this object by separating the boiler into parts, placed verti-

cally one above the other; the lower part forming the water-chest, and the upper part the steam-chest, connected together by large vertical tubes. The axles of the enormous driving wheels of this engine pass between the water and steam chests, in the apertures between the vertical connecting tubes of the boiler. No detailed drawing, however, being exhibited with this engine, it is impossible to say, from an external examination only, whether a boiler of this construction will generate steam with sufficient rapidity to supply an engine of such unusual size, from which its constructors expect to obtain a speed of one hundred and fifty miles an hour. The total weight of this engine, the largest yet constructed, is stated to be 60,000 kilos, or about 62 tons.

Whitworth, of Manchester, exhibited a full collection of his admirable tools, which, for judicious design, accompanied by excellence in the castings of which they are composed, far surpassed every thing else in the same line to be found in the building.

But the production of tools for engine and machine building is becoming an object of great attention among the principal engineering establishments of all countries: a wider range than that hitherto taken in this department by British makers being taken by those of France, Germany, the United States and Canada, all of which countries exhibited tool machinery for the working and shaping, not only of iron and other metals, but also of wood and stone.

In the Exposition, samples of iron cables are exhibited by M. Sisco, of Paris, together with a model of the machine, of which he is the inventor, for making them. Each link is formed of a long band of laminated iron, 1 ¼ in. in width, which is wound round and round upon itself in an oval ring of the required length, passing through the preceding link. The making and shaping of each link requires 2½ minutes. The chain, thus made in one, is plunged, when completed, into a white-hot bath of copper or malleable cast-iron, in which it remains from five to six minutes, according to its size. The advantages which this maker claims to have secured are, increase of strength and durability, combined with greater lightness and cheapness, above other metal cables of corresponding diameter.

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THE PHŒNIXVILLE IRON WORKS.

The American manufacture of railroad iron now reaches many thousand tons annually—enough at least to lay over 1,000 miles of single track road. The first rails rolled in this country, were made, we think, at Danville, Pennsylvania. This was in 1845. The Peter Cooper mill at Trenton, N. J., commenced shortly after. In 1846, the Phœnix Iron Works (then in the principal ownership of David Reeves, Esq.) commenced rolling rails also. The extent and regulation of these works warrant, therefore, some general sketch of them.

The ore used at the Phœnixville Works is gathered in from 8 to 35 miles from the works, furnishing six different varieties. Among the ores used is the Warwick, from the old Warwick mines, which are said to be the oldest in the United States, having been opened as early as 1809. These ores have been worked over sixteen acres of surface, and to a depth of one hundred and fifty feet. They furnish a primitive ore, yielding 60 per cent. of iron. Another ore is a hematite, yielding 40 per cent. Another is a primitive magnetic ore, yielding 55 per cent., and containing a small quantity of lime, which is an advantage in smelting. Another is the Oakley ore from Reading; a primitive, not magnetic, and free from sulphur. This ore gives 38 to 40 per cent. From 45,000 to 50,000 tons of ore are used yearly, making over 10,000 tons of pig iron, besides which 10,000 tons of pig are purchased yearly from other manufacturers. From 1,500 to 1,600 tons of anthracite coal are used weekly, or 80,000 tons yearly.

There are three hot-blast furnaces, 12, 13, and 14 feet diameter respectively, at the boshes, and 38 feet high of stack. These turn out, together, from 300 to 335 tons a week. The blast is supplied by two steam engines and four *blowing* cylinders. The blast is kept at from 3 to 4 pounds pressure, per inch, *as required.*

There are 10 steam boilers suspended over the blast furnaces, and heated by the burning gas therefrom. There are also three 40 inch boilers below, which are *ninety feet in length*, being probably the longest in this country. These boilers are also heated by gas led through a flue from the furnaces. There are also six boilers 28 inches in diameter and 32 feet long, which are heated with coal whenever the other boilers are not in use. Thus, then, the entire steam power of the concern is supplied with waste heat, except at times when the gas does not work well, or the gas burning boilers are under repair. The steam is carried from the boilers, many hundred feet, to several of the steam engines about the works.

The rail mill and East and West puddling mills occupy a space 444 by 192 feet.

There is also the North puddling and merchant mill, 190 by 150 feet. In all, the mills are equal to 65 single puddling furnaces, many being double, and 17 heating furnaces.

Over these furnaces are, in all, 49 boilers, to supply the engines which work the rolls. These boilers all feed into one main steam pipe, which makes the circuit of the mills.

All the puddling furnaces have a heating oven. In this oven the pig-iron is heated with waste heat, preparatory to puddling. This saves over 15 per cent. of the time which would be required in puddling from cold iron, as in the old manner the puddler took but five heats a day, while he can now take six.

In each of the three puddling mills is a rotary squeezer, in which the slag and cinders of the puddled balls are worked out. The balls are afterwards taken to the puddle rolls and worked into bars, of 14 feet in length, and 60 or 70 pounds weight each. All around the puddling mills is an overhead rail or track, from which is suspended a travelling platform, on which is piled the pig-iron for stocking the different furnaces, and for carrying the puddle bars to the shears, and thence to the re-heating furnaces. In stocking the furnaces particularly, the overhead track, with two men, does the former work of 3 men with a horse and cart.

The puddle bars coming from each furnace are kept separate, and the product of each day's work of the furnace is weighed at one lift, and moved on the travelling truck.

The puddling furnaces produce 450 tons of puddled bars per week, using 500 tons of pig, the loss of weight being from 10 to 12 per cent.

Most of the iron worked at Phœnixville is of the "red short" quality—that is, brittle while hot, and tough while cold. This is better and stronger for most purposes than cold short iron, which has opposite qualities. In forming a pile for a rail, bars are laid up to form a pile 6 inches wide and 5 inches high. On the top and bottom of this pile is laid a bar, 6½ by 1 inch.

The whole pile is finally heated and put through the roughing and then through the finishing rolls, there being 5 grooves in the former and only four in the latter. The rail is then carried to the saws and cut off at the ends. From thence it is drawn endwise to a hot straightening plate, where it undergoes that operation, and is then pushed on to the hot bed to cool, after which it is transported by an overhead railway to the cold straightening machine. This has a powerful moving die worked by an eccentric. The rail is laid upon the machine, and a man sights the rail, and brings any discovered bend under the die. A swedge, of a wedge-shape form, is held between the rail and the end of the die, and the latter coming down slowly and with great power, brings the end into a straight line. Rails were formerly straightened by hand with heavy sledges, a laborious and imperfect process indeed. The Welsh mills have quite lately adopted the power straightener. It is very useful in straightening heavy shafting, the bars for which are made at Phœnixville, and an idea may be had of its power, when we add that it has broken square off a six inch square bar of iron, quite cold.

The rails are next chipped and filed smooth at their ends, and afterwards carefully inspected, *punched, and* piled up for delivery.

The works run night and day, and employ over 1,100 men and boys in all, one half that number being at work at a time. The monthly payments of wages are $40,000. The entire cost of the works, with stock at any time on hand and working capital, is nearly $2,500,000. There are 225 tenant houses, occupied by the workmen, and belonging to the property.

These works are now turning out 400 tons rails, 100 tons merchant bar, and 20 to 25 tons railroad spikes and wrought iron chains *per week.*

Rails 25 feet, (66 lbs. to the yard,) have been rolled continuously at the rate of *one per minute.*

In the entire works there are ten steam engines.

These works have also a large machine shop, foundry, smithy, etc.

The whole establishment is the property of Reeves, Buck & Co. of Philadelphia. This firm owns also the nail works at Bridgeton, New Jersey.

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### RATE OF STEAM DIMINUTION.

Mr. Dunn introduced the following data, to show the rate of steam diminution under different circumstances. The calculations were made by Mr. Horsley, engineer, of Seghill, on a boiler 27½ feet long, 6 feet diameter, and a safety-valve with an area of 3 inches:—

| Steam Indicator, 25 lbs. | End of 5 min. | 10 min. | 15 min. | 20 min. |
|---|---|---|---|---|
| 1. Fire door open | lbs. 23¼ | 20¼ | 18 | 16 |
| 2. Fire damp | 21¼ | 18¼ | 16 | 14 |
| 3. Fire pulled out | 22¼ | 19 | 16 | 13¼ |

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### MONSTER ROLLING-MILL FOR RAILS.

An event of some importance to the district, came off recently at the Llynvi Iron Works, South Wales, by the opening of a new rail-mill and puddling-furnaces, the former said to be the largest in the world. Mr. Richard Evans, the forge manager, officiated on the occasion. On the iron having attained the proper heat, a large mass was seen to issue from one of the furnaces, pass over the iron floors, and being conducted into the rolls, the manager drew forth the first rail, the whole operation being performed with perfect success. These mills and furnaces, when in full work, are said to be capable of turning out 50 tons of rails in 12 hours. The driving-wheel alone weighs 76 tons, and the fly-wheel 65 tons.

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### REVERBERATORY FURNACES.

Messrs. W. and T. E. Williams, of the Abersychan Iron works, near Pontypool, have secured by patent the arrangement of several reverberatory furnaces together, so that one fire may heat either or all of them. The inventor supposes the most convenient arrangement to be as follows:—The fire-place or furnace is made with three bridges, one at each of three of its sides, and a reverberatory furnace is constructed to each bridge; the flues are arranged to exclude cold air from the body of either of the furnaces, and heated air is introduced to insure combustion.

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### THE ORIGIN OF WIRE ROPE: ITS QUALITIES AND ECONOMY.

At the British Association, Mr. Andrew Smith, C. E. (who is the patentee of the wire-rope), in commencing his paper, said that, in approaching any section of that important association, and seeking the opportunity of occupying any, though but a small portion, of its valuable time, it was due not only to the body itself, but to society at large, who looked so anxiously for the result of the Association's labors, to remember how important were the objects of those meetings, and how immensely extended the field of those operations, and, therefore, to offer for their patience and consideration subjects, not only of

general interest and benefit, but which should present cause for engaging attention at the particular period at which such subjects might be presented. It was under such impression that he ventured to offer the paper for perusal: the subject was "Wire-Rope; its various manipulations and appliances; its commercial value and national economy" Amongst those manufactures to which might be given the appellation of "things of the day," was the invention of wire-rope, and so he claimed a few moments of their valuable time. Few manufactures were entitled to more of their consideration than the manufacture of various appliances of wire-rope, as a substitute for Russian hemp, or converting the metallic produce of the British Islands into a substitute for the vegetable produce of a national enemy, and his numerous serfs. It was in the year 1828 that the author of the paper first applied wire-rope as a substitute for catgut, in aid of another invention of his for "Metallic Shutters." The rats had destroyed the strength of the catgut line by eating it; the position of the sheave or pulley was so placed, and made so narrow in the groove, that none but a small substance could be applied to that particular case. Necessity, after all, was the mother of this invention. Time rolled on, and the author anxiously watched the working of this experimental metallic cord; four years were spent in experimenting, in order to test its strength in comparison with hempen rope and chain, as regarded weight, size, strength, price, durability, and economy. This required time, patience, and a heavy outlay of capital. On the 12th January, 1835, the first patent was obtained by Mr. Smith, and in 1839 he had obtained his fourth patent. At this time the wire-rope had been applied to a great many purposes, but more particularly for the standing rigging of ships, both in her majesty's navy and the merchant service. In the year 1841, other makers came into the field, and the manufacture has increased much since that time in various profitable appliances, from the working of time-pieces to the working of intelligence through the agency of the submarine telegraph wire-rope cable. He exhibited two specimens, which, he said, formed the subject of his fifth and last patent for machinery for manufacturing submarine cables and wire-ropes generally. In practice they were found efficient in their operations, producing great facility in the manufacture, with very little friction in the rubbing and bearing parts. A tabular scale which he produced, showed, he said, the utility and economy of wire-rope as applied for standing rigging in her majesty's navy; from this it also appeared that at the time the estimate was made, a saving might be effected of £28,582 on £114,330, being more than one fourth. This was at a time when the price of hemp was less than half its present price, it being then only £40 per ton, whilst it was now nearly £90; and the rope was then nearly half as dear again as at the present time, it being then £60 per ton, and now only £40. Mr. Smith concluded by exhibiting and describing two models, one showing the applicability of the wire-rope for standing rigging, and the other for mining purposes.

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ROLLING OF TAPER IRON.

At the British Association, Mr. Clay read a paper "on the rolling of taper iron, as carried on at the Mersey Iron works." This manufacture is only practised at these works, Sefton-street, Liverpool, under a patent granted to Mr. Clay. The paper stated that the chief use to which rolled tapered iron had hitherto been applied, was for ships' knees and fastenings, and as it was mentioned that no less than 2,250 tons were made last year at the Mersey works, the manufacture must evidently be of some importance. Ships' knees were formerly made by the tedious process of hammering, and it was clear that while rolling was a cheaper mode of production, the quality would be improved by reason of a greater uniformity. The model of the machine was exhibited, consisting of two hydraulic cylinders, placed above the usual standards on which the rolls are usually mounted. These cylinders are fitted with pistons and rods, which slide through the ordinary screws that retain the upper roll in its place. There are suitable valves, by which water, or other fluid,

is allowed to enter and escape from the cylinder. When a bar is about to be rolled, the cylinders charge themselves through the clack-valve, and the operator opens the ejection-valve as much as is considered necessary. He then forces the bar through the rolls, when the pressure causes the upper one to attempt to rise. This pressure is communicated through the piston-rod in the hollow screws to the piston, and according to the rate at which the water is allowed to escape, so is the gradual rise of the roll regulated, and the proper taper produced. On the first attempt, perhaps the roller-man will not get the desired taper; he then alters the valve a little, and, after a few trials, gets the required taper; then, by a jam nut on the exit-valve spindle, fixes it in that place, and makes as many copies of the bar as he requires. The management is so simple that scarcely a single bar is ever spoiled; certainly, the waste does not exceed the rolling of merchant iron, and the production is equal. In nine hours 21 tons of this iron have been rolled, which would take a hammer more than a fortnight to produce, or in the proportion of one mill to 20 forge hammers. Although, as stated above, the employment of this iron has hitherto been confined to ships' knees and fastenings, it is evident that any article of tapered form may be made in a similar way, such as anchor shanks, railway switches and points, mill shafts, tapered both ways, springs for carriages, and other articles. The greatest weight hitherto rolled has been about 8 cwts.

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### GASES.

Mr. C. Chenot, of Paris, has patented some improvements in accumulating, conducting, and treating gases of combustion, and also in generating and applying the same to metallurgic and other purposes. "The ends of my improvements (says the patentee) are, to impart to gases a constant richness, and also a three-fold calorific, chemical, and mechanical action. The first of these ends is attained by subjecting gases to normalization, which produces a constantly rich gas, shut up under gas-metres, from whence it is supplied. Next, decantation of gas constitutes a novel means of enriching gas, giving rise to a variety of applications in practice; generating gases under the influence of carbonates, doubles their calorific power; the revivification of carbonates renders said carbonates useful in every respect, generating gases by pulverulent feet under the influence of steam or gases, such as carbonic acid, imparts to the gases generated an absolute richness for burning; hence the above operations form a complete series of practical means for enriching gas, and producing the highest degrees of heat, as well as the most energetic oxidizing and reducing actions. Having thus obtained the calorific and chemical action, there is only the mechanical action left. This latter is insured by burning gases which are being mixed with the air at the moment of the combustion, without any previous mixture with air, which would be dangerous and incomplete. This mixture is instantaneously accomplished by moving the tuyere, which changes the oxidizing action into a reducing one, so that by an easy mechanical action the chemical one is obtained. The mechanical action is completed by the gases being projected with a great pressure, and thus acting like the tools which are used for producing reaction by stirring or agitating in common practice."

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### IMPROVEMENTS IN IRON MANUFACTURE.

We have lately alluded, on several occasions, to the very favorable results obtained under the processes patented by Mr. Morries Stirling and Mr. Talabot, and have now the pleasure of giving an outline of the several specifications. Into the moulds, or chills, into which molten iron is run, a mixture of any of the purer oxides of iron, combined with combustible matter, is introduced. Chemical action ensues, and the nature of the pig-iron is changed, so that when afterwards subjected to the process of puddling, it is more readily converted into malleable iron; the quality of which is improved, and may be

changed, by the addition of other oxides, salts, &c., either added in the moulds at the same time with the mixed oxide of iron, or afterwards.

The oxide of zinc, when used in very small proportion with the oxide of iron, is found very much to improve the quality of certain kinds of iron; and the patentees prefer using it so combined. Increased toughness, brightness, and resistance to tensile force, result from the proper use of these oxides. Oxide of tin produces closeness of grain, hardness, and a fine crystalline texture —very well suited to the wearing surfaces of rails and tyres. The oxides of the earthy bases—such as those of calcium, barium, &c., are employed in a similar manner, and are found to remove certain defects in the resulting malleable iron. Certain salts of the metals are employed in the same way, and for similar purposes.

The combustible matters employed by the patentees vary according to locality, on account of cheapness, carriage, &c.; and a large choice of such substances is given—ligneous matter, turf, resinous, oily, and fatty matters; and according to the quantity of the gaseous matter which they give off, so is their proportional bulk to that of the oxides employed; the smaller the residuum which is left, and the larger quantity of gas which they yield, rendering them more or less eligible.—*London Journal.*

### HARDENING CAST STEEL FOR CUTTING.

Kieser, of Issy, in Switzerland, prepares admirably hardened razors, penknives, &c., from English cast-steel, by plunging the blades, at a dark cherry-red heat, into a bath made of 14 parts, by measure, of yellow resin in fine powder, 2 parts fish oil, and 1 part hot melted tallow; they are then allowed to cool perfectly, and without wiping them, are re-heated to a low red heat, and immersed in water in the usual way of tempering such articles. The edge of the blade treated in this manner is said to be very fine, and the hardening more uniformly done than by any other process.—*London Artisan.*

### IMPROVED TUYERE.

A tuyere is an apparatus placed at the point of the blast tube to admit air into smelting furnaces to regulate the blast. As this is a very important matter in the smelting of metals, various improvements have been made in tuyeres to effect the objects desired in the most perfect manner. These seem not to have attained to perfection yet. Levi Kellogg, of Scottsburgh, N. Y., having made application for a patent for another improvement, which consists in having a taper opening made through a cylinder (which works within a box) set opposite the tube which receives the nozzle of the bellows. By turning this cylinder, either the large or small opening for admitting air through the cylinder is brought opposite to the fire, and thus the blast is either increased or diminished in breadth, according to the amount of heat required. This tuyere is suitable to forges as well as blast furnaces.

### THE ROLLING MILL OF WREN BROTHERS & CO.

The Philadelphia *Ledger* states that the new Rolling Mill of Wren Brothers & Co., at Palo Alto, Schuylkill County, is nearly completed. It is 160 by 140 feet, contains seven puddling furnaces, one scrap furnace, and two re-heating furnaces, one quide mill, for making small merchantable iron, nail rods, &c., one rail and merchant mill, one boiler-plate mill for rolling boiler or flue iron, one tilt hammer for drawing out purposes, one puddling train or roughing mill. This is the second rolling mill in operation in the vicinity of Pottsville. The *Miners' Journal*, speaking of the mode of making T rails, or merchantable iron, from the metal, says the melting iron is taken out of the furnace in lumps of about four hundred and fifty pounds—originally weighing about four hundred and eighty pounds, therefore losing thirty pounds to a heat—and thrown into the rotary squeezers, or alligator squeezers (as the case may be), and thence it is put through the puddling train, made into flat bars, and then cut

into short lengths and re-heated in the re-heating furnace, to be rolled for merchantable iron or rails. About one-third or more of the composition of rails should be re-heated iron, a piece of which is laid on the top, and another on the bottom of the rail. The generality of English iron is not so good as our home-manufactured iron, from the fact that they put little or no re-heated iron in their rails, and consequently they *shell off* and wear out in a short time, with but little usage.

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LAP-WELDED IRON TUBES.

The first Lap-welded Iron Tubes which were ever seen in this country, and the only ones suitable for the Boilers of Steam Engines, were imported by Thos. Prosser & Son in the year 1845. Vainly did they endeavor to arouse attention to the importance of the subject. Nobody wished to be disabused of their old notions, that copper tubes or clumsy gas pipes were "good enough." "True, they were apt to leak badly," but that "could not be helped," and "new boilers were wanted the sooner," which answered very well the purpose of boiler makers; besides, they "did not like tubular boilers at all," and "preferred flue boilers," as being more profitable to make.

The methods of fixing iron, as well as other tubes in the tube plates, were also very rude and inefficient, and more dependence was placed upon the joints filling up with rust and thus stopping the leakage, than upon the quality of the workmanship applied. Scarcely less vicious in principle is the method of attempting to fasten tubes with conical ferules or thimbles, driven inside of them, which, in addition to stopping the draft, prevents any efficient means being applied for the purpose of cleaning them out.

Since that year (1845) Thos. Prosser & Son have introduced various improved methods of preparing and fixing tubes, drilling the tube-plates, and, in short, have entirely altered, and as they believe, materially improved on the economic arrangements of the workshop, and increased the durability of tubular boilers, by causing a better and more efficient class of men to be employed in the construction of them, as good mechanics alone are equal to the use of the tools which they have invented and introduced into the service of fixing tubes properly into the tube-plates of boilers. Although the changes cannot be denied, there are doubtless many who will deny their claim to being the authors of them, which is always to be expected of successful inventions—nobody claims the unsuccessful ones.

The experience thus obtained and daily improved upon, superadded to that of Mr. Richard Prosser, the English patentee and inventor of the only machinery capable of making a perfect lap-welded tube, has resulted in a combination or system of working, which is now for the first time placed before the public in a pictorial form without an apology, as it is deemed of sufficient importance to stand upon its own merits, as introducing or at least laying the foundation for a more extended introduction of arrangements, requiring skilled labor—always the cheapest, and cheaper material, and at the same time attaining far greater strength and security from explosions.

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## JOURNAL OF GOLD MINING OPERATIONS.

CALIFORNIA GOLD FIELDS.

The point of most prominent interest respecting the gold fields of Califor*nia, is the change* which is taking place in the system of mining pursued there.

It was stated in these pages years ago, that the time would come when mere washing the earth, with no capital but a spade and pan, would give place to large outlays of capital and the exercise of science and skill in this pursuit. Capital and science are now rapidly taking the leading place in obtaining the gold. The following sentence from a recent paper recognizes the change:

Those who go to the mines now must not go with the intention of skimming the surface, and picking up an easy fortune in a few months. The character of mining has changed very materially since 1849 and '50. Shafts are to be sunk to an immense depth, tunnels run far out of daylight, into the darkness of the mountain's base, hills to be washed down, and rivers to be drained. * * * * * * The time has passed when the adventurer needed no aid but the knife to pry the glittering metal from the clefts of rocks, or the pan to prospect the ravine. Concentration of capital is now necessary to build flumes, to sink shafts, to tunnel the mountain, and even to wash down the hill side. There is gold enough to employ the labor of centuries, but it can no longer be obtained as formerly. Unity of effort and capital are called for.

Our previous pages contain extensive particulars of fluming operations, and the methods of diverting water to the dry diggings. If we had at hand sufficiently full details of some of these operations, respecting which our information is only general, some of our readers might regard the statements as hardly credible, in consequence of the extent and magnificence of the enterprises.

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### QUARTZ MILLS IN NEVADA CO.

The following statement is derived from the recent State census of Nevada county, which is a field of extensive quartz mining operations.

The number of quartz mills in successful operation, are sixteen; five of which are run by water. The quantity of ore crushed per annum:

| | |
|---|---|
| Tons | 75,000 |
| Average yield per ton | $25,00 |
| Cost of quarrying, hauling and crushing, per ton. | $15,00 |
| Aggregate value of machinery | $300,000 |

The total amount of original investments in quartz, is estimated at $2,000,000; this amount will be doubled in a few years, for it is proved beyond dispute, that our quartz veins are not only remunerative, but inexhaustible. At the very lowest calculation, I put the annual yield of gold in the county at $5,000,000.

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### STEAM PUMP FOR GOLD MINES.

In the Telegraph, published in the same county, we find the following particulars of a pump, recently patented for draining the shafts of the gold mines:

We alluded, a few weeks since, to a "steam pump," which was then on its way to "Iowa Hill," and expressed a conviction that it would prove eminently successful. The result of its performances, so far, have more than realized the expectations of its projectors. We look upon it as the most important improvement which has yet been made, for a cheap and thorough development of a large proportion of those mines, as yet unopened in the State. It will bring about a complete revolution in all mining operations of any considerable depth, where the works are impeded by large quantities of water.—We copy from the "Iowa Hill News" an account of the working of this machine (the only one yet in use) in that place.

"Since Wednesday last, Mr. Stein's apparatus has sunk a shaft four by eight feet on the Iowa City Company's claim, to the depth of fifty feet. The cost to the Company of sinking the shaft, curbing, &c., to the required depth (two hundred feet), will be less than three thousand dollars, which, when the immense cost of prospecting by a tunnel is considered (frequently fifteen and twenty thousand dollars), must convince all of the great advantage and economy of this mode of prospecting hill diggings.—The apparatus is visited daily by hundreds of miners, and all speak in the highest praise of its operations.—The boiler is of the same kind as that of a locomotive, and it, with the engine, occupies about the same space, and has somewhat the appearance of a railroad engine."

In addition to the above, we give the following letter from the inventor and builder of the machine. It was written in answer to our note of inquiry in the "Telegraph," two weeks since.

SAN FRANCISCO, October 18, 1855.

MR. EDITOR:—In reply to the accompanying note, I beg to say that these portable machines are made by the Vulcan Foundry Company of San Francisco, who have just despatched the one referred to, to Iowa Hill, and are prepared to furnish them in any required number.

The machines consist of a locomotive boiler, upon the side of which is bolted a double engine, one cylinder of which is for steam and the other is for air, being in point of fact a steam and air engine. From the air engine is conducted a flexible tube, through which compressed air is driven, and which is attached to a double force and suction pump, placed near the bottom of any shaft proposed to be pumped out. When the compressed air has expended its force in working the pump it exhausts into the shaft itself, thus giving a powerful ventilation.

The water to be pumped up is forced through a hose to the surface of the ground, and discharged. It will be noticed that the cumbrous intervention of rods to work a pump at the bottom of a shaft is dispensed with, and flexible tubing, of any required length, introduced to conduct the motive power from the engine, on the surface of the ground, to the pump at the bottom of the shaft, which can thus be raised or lowered at pleasure, without having, as in the old process, to disconnect rods, &c.

At the front of the boiler is a hoisting drum with friction clutch, to raise the dirt buckets as they are filled by the workmen in the shaft.

The whole machine is mounted on four wheels, and can be transported with the same facility as a common wagon, requiring but four horses to draw it. It can be drawn over a shaft already commenced, steam got up, its pump lowered and set, and its hoisting gear prepared in half an hour after its arrival on the ground; and after the shaft is sunk to the required depth, it can be as rapidly removed to another position. It is designed to accomplish speedily and conveniently, the three-fold purpose of hoisting the dirt, draining the shaft, and supplying the workmen with fresh air.

The machine, as above described, is caveated by me, and a patent will be applied for by this mail.

The cost of a six horse power machine, complete, with power to use, is $3,200; for a 12 horse ditto, $4,200. Respectfully yours,

EDWARD T. STEIN.

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### DECLINE IN THE SHIPMENTS OF GOLD.

The decrease in the shipments of gold from San Francisco, for 1855, as compared with 1854, will exceed six millions of dollars, and as compared with 1853, eleven millions. The complete shipments for the year, have not as yet been received. For ten and a half months they compare as follows:—

| | |
|---|---|
| From January 1st to Nov. 16th, 1853, | $49,752,705 |
| From January 1st to Nov. 16th, 1854, | 44,744,466 |
| From January 1st to Nov. 20th, 1855, | 38,680,006 |
| Falling off in 1854 from 1855, | 5,018,239 |
| Falling off in 1855 from 1854, | 6,064.460 |
| Falling off in 1855 from 1853, | 11,082,699 |

The cause of this decrease is an important question. If it should arise from a decline in the yield, it would be a subject of serious consideration. Happily, however, those who are on the spot, and who are the most familiar with all the circumstances, ascribe it to no such cause. Their views are as follows:—

It is generally conceded, that the amount of gold exported the present year will fall far short of that of 1854. Since the 1st of July last, however, the ratio of exportation has nearly equalled a corresponding period of 1854. The great disparity occurred in the early part of the year, when, owing to the consternation created by bank failures, few bills of exchange were purchased by persons returning to the Atlantic States, each one choosing to be his own carrier, and in this manner no account was taken of much of the gold that went out of the country. Again, the country was pretty well drained of the precious metals during the latter part of 1854, by the heavy shipments of a particular banking house, which strained every nerve to sustain a rotten institution on the other side. Not only dust, but coin was shipped, until, comparatively speaking, scarcely a dollar was left. As a consequence, moderate shipments only could be made in the early part of the present year.

But the great cause of the reduction in shipments is evidently other than these, and yet that cause is not a decreased productiveness of the mines. Were figures accessible, they would probably show that the actual product the present year, has been as great as at any other corresponding period, since the discovery of the mineral wealth of the country.

The cause to which we refer is the decreased importation of merchandise during 1855, and the consequent lessened necessity of sending hence the products of the mines. Since 1852, there has been no period in which we imported so little, as thus far we have imported the present year. The freight lists alone, in 1853, were enormous. For months the arrivals averaged two clippers per day, and over six millions of the wealth of the country was drained from it by one article alone—flour. Goods were received and stored, and though they were not needed, nor in many instances paid for—as they were consigned, and often went to waste—their very reception entailed an amount of expense which was burdensome to the country.

Evils often right themselves, and such was the case in regard to this over-importation. The losses incurred by shippers hither induced them to desist, and a more healthful tone in the mercantile marine, and in business generally, followed. People found out that California could not consume the whole world's produce, and manufactures, and wisely concluded to leave us alone for a season.

Meanwhile agriculture sprang up as if by magic. It was scarcely supposed that California could rear any thing in the way of farm products, till the experiment was tried on a limited scale. We well recollect when a fleet of sixteen vessels was sent to the Sandwich Islands, for potatoes, and returned without them to a market where the article commanded fifteen cents per pound. This set people thinking that possibly California might raise her own potatoes, and other garden products, and not be necessitated to send abroad for them. The experiment was tried, and it is unnecessary to say that it succeeded. This was three years ago, and we are now exporting largely of almost every agricultural product we formerly imported—flour, wheat, barley, oats, potatoes, and so on to the end of the chapter, and the only question now is, where shall we find markets for our surplus? All this has kept money in the country, and in the same ratio has lessened the exports of treasure.

Besides, manufactures have arisen, and the dairy too is doing its part to aid

in keeping our gold at home. Of the necessities of life, the catalogue of those for which we must continue to look abroad is meagre. Even some of the luxuries we can readily produce, and as time progresses the number must increase.

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### THE TREASURES OF TABLE MOUNTAIN.

Every day brings to light more of the inexhaustible wealth of Table Mountain, in Tuolumne county. Although it has been supposed by some that the representations made in regard to this wealth, are designed to get up an excitement for the benefit of the neighborhood, we can see no reason for such suspicions, as every available foot of ground has been taken up. From the Sonora *Democrat*, whose statements we cannot doubt, we learn that the success of the miners is unabated. The existence of large deposits of the precious metals cannot be questioned, and it is only through years of patient toil that they have been developed. For instance, the company of Messrs. Oliver, Lyons & Co., after two years faithful labor in the cutting a tunnel, only a few weeks ago reached the object of their search. This tunnel is eleven hundred feet in length, and cost over sixty dollars per foot. It is mostly through solid rock, and at one section, by the most arduous labor, they were enabled to advance but six inches during three weeks time. This is an instance of confidence, perseverance and patience, almost unparalleled in the mines. Other examples also abound and are enumerated by the *Democrat*:

Among the new shafts that are in a state of progress, we may mention those of the Hilderbrand Company, the Golden Shaft, Dragoon Claim, Duffield, Yaney & Co. Claim, Deadfall Claim, Moreland, Reese & Co., Gilkey Claim, and others. The Dragoon Claim have reached a depth of forty feet, through a solid rim of scoria, at a cost of $28 75c. per foot, which is about the average cost of the other shafts in the vicinity. Mann & Co., on the brow of the mountain, after descending one hundred and sixty-nine feet, are taking out the richest ore we have seen in California. By stirring up the dirt with a stick, we could pick up scales of gold of the value of from twenty-five cents to three dollars. The gold is of the same quality as that found in river beds, and all concur in the belief that the lead occupies the bed of an ancient river. Dr. Somers, of the Columbia Company, has two shafts in operation, and another in progress. He is taking out dirt, the estimated value of which is two ounces to the cart-load. Huge piles of this valuable dirt are being heaped up in every direction of the "diggings." That of Valentine & Co., is valued at $80,000—Johnson & Co.'s $25,000—Sampson & Co.'s $35,000—Caldwell's $75,000, and so on through numberless artificial mountains of the precious ore. Water is all that is wanted to separate the pure metal from the dirty dross, and when the rain shall come we may all feel the benefit of its long prayed for advent.

Nor is the wealth of Table Mountain confined to gold alone. From the same source we learn, that besides the rich discoveries in gold that are constantly being made, several valuable diamonds have been found near Byrne's Ferry, and a new and beautiful substance, resembling the opal, has been taken from a tunnel, in considerable quantities, in the vicinity of the Table Mountain House. Although the editors have not personally seen these specimens, they are assured upon authority in which they place every reliance, that one of the diamonds tested in Sonora, possesses the value of sixty dollars. The discovery of these precious stones will doubtless lead to further investigation, and should be prosecuted in a manner satisfactory to the public.

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### AUSTRALIAN GOLD FIELDS.

The latest report from Australia, states that in the gold fields important discoveries continue to be made, and the general yield is on the increase, not only in the older, but in the more recently opened rushes. The progress of discovery is principally in the direction of the north-west portion of the colony,

but the prospects in the east are of a favorable character. At Kangaroo Point, Fryer's Creek, several new rushes have taken place. A great public meeting has been held at Victoria, at which a committee was formed, for the purpose of organizing an association to agitate for the opening of crown lands. The exports of gold for Melbourne, during the second quarter of 1855, are valued at £2,952,692, against £2,286,565 in the same period of the previous year. The shipments to Great Britain are to the extent of £2,675,998 this year. In 1854 they were £1,723,187. The price of gold continues the same as last reported (£3 16s. 6d. per oz.) In the Ballarat districts a great deal of attention is directed to the Burrangong Ranges, at present the scene of some rushes, which bids fair to be a favorite quarter. Wardy Yallock is still prosperous. It is reported a discovery has been made at Lake Omeo, at which a rich yield is being obtained. The field had been tried when gold was first discovered, without any important results, for although gold was found, it was not in sufficient quantities to compensate for the labor expended. Quartz-crushing continues in favor, but as yet there are no means of judging to what extent it has succeeded, as no amalgamated gold has been brought into the markets.

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THE GOLD MACHINES—CASTLE DINAS MINE.

It may be remembered, about twelve months since, the extraordinary rise in these shares, and the consequent ruin of many of the adventurers. This mine was one of those early in the field, represented to reap an immense fortune from Berdan's gold-crushing machine. Last week the whole of the materials were submitted for sale, by auction, and amongst the lots Berdan's machine, which cost the company upwards of £2,000, was put up, and absolutely sold for the sum of £25, being about the value for old iron.—*London Journal.*

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THE GOLD BEARING ROCKS OF THE WORLD.

Evan Hopkins, Esq., read a paper before the British Association "On the Gold-bearing Rocks of the World, and their Superficial Metallic Productions." The following is an abstract:—The gold-bearing rocks belong entirely to the primary crystalline series, noticed in the preceding paper, and not to the fossiliferous or sedimentary rocks; therefore gold is never found in the latter, excepting by the intrusion of the former from below. The less the primary series of rocks are covered with compact sedimentary rocks, the more favorable they are to develope and liberate their metallic contents. It is the superficial disintegration and final decomposition of the edges of the meridional bands of granite, gneiss porphyry, schists, and quartz, that produce the great auriferous deposits of South and North America, Australia, Africa, India, and Siberia, as illustrated in the accompanying sections, to which I beg reference for explanatory details. These superficial disintegrating actions of the auriferous crystalline rock are confined to no age, nor any given period in the history of the sedimentary rocks. On the contrary, they are incessantly going on, and only varying in their amount and intensity according to local physical conditions. The richest variety of the auriferous rocks retain their normal meridional structure, as seen in the Brazils, New Granada, California, Siberia, India, Africa, Australia. As these primary crystalline series of rocks are universal, and are seen in every part of the world, when not covered by sedimentary rocks, it follows as a natural consequence that gold is also detected in variable quantities in all primary districts, but the larger accumulations or superficial productions of gold are only found in the ferruginous talcose schists, &c., where the meridional cleavage is well developed, as shown in the sections of the Andes, California, and Australia, to which I beg particular reference. Therefore, to predict the existence of gold in any given region or district in quantities worthy of commercial consideration, it becomes necessary to ascertain the following conditions:—1. The primary series uncovered by sedimentary rocks

and subject to disintegration and decomposition.—2. That they exhibit more or less their normal, vertical and meridional structure.—3. That the crystalline bands predominate in ferruginous argillaceous schists, with talcose and quartzose bands.

Some of the old and altered sedimentary rocks in contact with the primary base, and intersected by quartz veins, impregnated with pyrites, from the schists below, are sometimes slightly impregnated with gold; but such instances are extremely rare, and the quantity of gold obtained is insignificant. The gold quartz veins enclosed in the primary slate (described in the Australian section) are only impregnated with available gold near the surface, and are never found sufficiently productive to pay for working many fathoms in depth. The only auriferous veins worthy of notice, and which are found to pay the cost of the ordinary operations of mining to great depths, are the auriferous pyrites, such as the Morro Velho, in the primary clay-slate of the Brazils and Marmato, and in the auriferous porphyry of New Granada.

The great productions of gold for the use of the world are principally obtained from the superficial deposits already noticed. The reason why it is generally supposed that quartz is the matrix which produces the gold, is because the precious metal, after precipitation, adheres more strongly to quartz than to the other auriferous rocks. Although the quartzose bands produce occasionally larger masses of gold, yet the quantity bears but a very small proportion to that which is obtained from the ferruginous and talcose slates. The richest auriferous bands are so subject, on being exposed to the air or moisture, to rapid decomposition, as to render it almost impossible to preserve the specimens.

Hence the cause why the gold is found so free from the matrix *in situ*. What are called deep workings in the auriferous districts must not be considered as sinking into the hard rock below, but simply sinking through the ferruginous consolidated gravel, down to the edges of the primary series, where the greatest amount of metal is always found. The ordinary gold fields only require water and manual labor to extract the metal; and, generally speaking, such gold deposits, if covered with multitudes of diggers, soon become exhausted, and leave behind them nothing but a barren waste and a scene of desolation, such as many of the old gold fields of Australia already present. The colony of Victoria, in 1852, with about 60,000 diggers, produced from two of the principal gold fields for that year equal in value to 14,000,000*l.*; 1853, with about 80,000 diggers, and about six gold fields, 11,500,000*l.*; 1854, with about 100,000 diggers, and sixteen gold fields, about 8,300,000*l.*; and this year, with upwards of 100,000 diggers, and more than twenty gold fields in different parts of the colony, I estimate the product, in round numbers, at about 7,500,000*l.*, and this obtained by applying machinery to re-wash the refuse of the old gold fields; and I expect that, by means of more liberal terms, and improved modes of washing, the produce of gold from the colony of Victoria will not fall below the value of 6,000,000*l.* for some years, but probably not obtained in the aggregate at a remunerative rate to the individual diggers.

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## JOURNAL OF COPPER MINING OPERATIONS.

### THE BRISTOL COPPER MINE.

We have received a copy of a report of a recent examination of the Bristol Copper Mine in Bristol, Connecticut, by Professors B. Silliman, Jr., and

J. D. Whitney. It is in several respects a valuable and important report for the copper mining interest to be familiar with. The ores yield a very low per centage, yet the Bristol mine is worked at a profit of $1,800 per month, by the new modes of mining and dressing which have been adopted. The ore sold this year returns $2\frac{51}{100}$ per cent. to the whole amount of stuff worked over. The peculiar nature of the deposit, also, is such as to possess much scientific interest. We shall, therefore, endeavor to present it entire in this and the succeeding number of this Magazine:

### *I. Situation and Real Estate.*

This well known mine is situated in the north part of the town of Bristol, Connecticut, about three miles from the Canal Railroad, and four from the centre of the town, where the depot of the Hartford and Fishkill Railroad is located. It is, therefore, very easy of access and near to market. The freight to New Haven, by railway, including hauling, is $2 40 per ton, and here most of the sales of ore have lately been made.

The real estate owned by the mine, in fee, is about 70 acres in one compact body, but the mining rights in a considerable tract beside, are held on easy terms.

The farm lands of the mine are good, and the farm is in good tilth. There is on the property a good dwelling-house for the manager, besides cottages, an office, store, and other buildings.

The water rights of a valuable stream are also owned by the mine, and the canal which brings it to the water wheels.

There is attached to the property an excellent peat swamp, which will prove of great value for steam fuel in the proposed extension of the works.

An accurate map of the whole property has been lately prepared.

The persevering enterprise with which this mine has been explored, the rich character of its ores, the extent and costliness of its former workings, and the general impression, lately much strengthened, that it possesses still greater wealth in its ore channels, all continue to make it a subject of peculiar interest to all who feel the national value of such investments and experience.

Its economical value is not diminished by the scientific interest attaching to the peculiarly complex nature of the deposit; but the full discussion of the questions connected with this ...ion of the subject, would be out of place in a report like this.

### *II. Geological Position and Nature of the Deposits.*

The Bristol Copper Mine is worked in a "contact deposit," between the sandstone of the Connecticut River Valley, now supposed by geologists to be of Liasic age, and the older metamorphic rocks, commonly called primary, but in all probability of the palæzoic system.

The direction of the line of contact of the two formations at the mine is about N. E. and S. W.

The linear extent of ground known to be metalliferous, by excavations made at various times, is between 1100 and 1200 feet. The principal workings are, however, concentrated in a space of about 600 feet North and South. There is good reason to believe that the metalliferous ground does extend at least 1500 feet, and perhaps considerably further. The mine is opened to the depth of 40 fathoms (240 feet) by an engine shaft, 6′×8′ in dimensions, sunk in the sandstone, and passing out of this rock into the great ore-channel at this depth. This is at present the only working shaft of the mine, and is used for hoisting the ore, for the pit-work, and as a ladder road to the levels. The width of the ore-ground from East to West, or at right angles to the line of contact, at the engine shaft, as exposed in the cross cuts and levels which have been driven, is about 120 feet, and this width is maintained at the lowest depth yet reached in the mine, and the same is true for a longitudinal extent

of about 500 feet, although it appears from the examination of the workings and what is known of their history, that the greatest concentration of metalliferous matter was near the surface in the vicinity of the engine shaft.

The character of the ore-ground or metalliferous belt is exceedingly complex.

Up to a recent period, however, the workings were chiefly in a series of micaceous and hornblende slates, sometimes passing into gneiss, and including large irregular "horses" of granite, which rock appears to have formed segregated masses, lying rudely parallel with the bedding of the schistose rocks. The strike and dip of these, however, is found throughout the mine to be very irregular, and there is evidence in the confused character of the ground, as well as in the slip joints and polished surfaces of the rocks, that motion of the various beds upon one another has taken place along lines of upheaval of limited extent and varying direction. The distribution of the ores in the metalliferous ground now under consideration, is found to be as irregular as is the structure of the ground itself. They consist principally of the vitreous, with some variegated ore, and a comparatively small amount of copper pyrites. The magnificent crystallizations found at the Bristol mine, especially of the vitreous ore, have given the locality a world-wide celebrity among mineralogists. In general these ores are found occurring in bunches and strings, which although preserving, usually, an approximate parallelism to the line of contact of the formations, cannot be traced continuously for any considerable distance. Hence the irregularity of the workings, especially in the upper levels, which have been extended in upon various branches of ore, or in search of others supposed to exist in certain directions, without any particular system or previously conceived plan. This has been the greatest drawback on the prosperity of the mine, since the orey ground was too wide to be all taken down by the miners, and the distribution of the branches of ore in it was too irregular to admit of their being found without occasional expensive excavations in dead ground. In general, throughout the mine, a tendency to a concentration of the ore around the masses of granite may be remarked, and the latter are not unfrequently well filled with strings and bunches of ore, especially near their exterior.

The limits of the ore-ground to the West, or in the direction of the older rocks, the sandstone being to the East of the contact-line, have never been well ascertained, and must be somewhat irregular, as would be expected from the nature of the deposit. Eustis's level, going North from the 20 fathom cross-cut, has been driven along a well marked and regular wall, which has been commonly called the foot wall of the mine. This dips, at an angle of 62° to the East, preserving a very near parallelism with the line of contact of the formations. The same kind of wall is seen in the 36 fathom level, immediately beneath where it is observed in the 20; but in neither level can it be traced for more than one or two hundred feet. There is nothing in the nature of the wall to indicate that ore might not be found beyond it, as appearances similar to this are observed in the ore-bearing ground of the mine. The excavations indicate that there was a tendency of the metalliferous matter towards this limit, and that there is not much probability of finding large bunches of ore beyond it. It is worthy of remark, however, regarding the ore-ground within the limits just described, that the average distribution of the vitreous copper is very uniform, so much so, that for a long period it has been found profitable to crush and work over nearly every stone from this belt raised in working the mine.

The ore ground just described was from the time the mine was first opened up to a recent period, considered as the only source in which the yield of copper was to be sought. Not long since, however, attention began to be called to a belt of soft rock, which lies next adjacent to the sandstone, and, of course, between it and the metalliferous belt just described. This belt is known as the "great flucan," (see diagram,) and it consists of a talco-micaceous slate, *completely* disintegrated and softened by some chemical agency, with the ex-

ception of a few bands and nodules of hard rock, but which are of very limited extent, compared with the softer portion. The flucan contains throughout its whole mass vitreous and other ores of copper, usually disseminated through it in soft particles, so as hardly to be visible to the naked eye, but occasionally concentrated into bunches and strings of considerable size. The width of the great flucan is 27 feet in the 20 fathom level, but it increases rapidly as the workings descend, being respectively 38 and over 50 feet, in the 30 and 40 fathom level. If this increase in width were to continue in depth, the flucan will meet the so called foot-wall of the mine at or near the 80 fathom level, occupying in this place a width of about 120 feet. But that such an increase in its dimensions continues downwards indefinitely, seems hardly probable; it is more likely that it will be found a lenticular mass swelling out to great dimensions, and then gradually contracting again. The mass of flucan has been traced on the surface and opened at various points. At the distance of 700′ to the Southwest from the engine-shaft, it has near the surface an inconsiderable width, although it may increase in descending; to the North, however, it holds its width as far as it has been explored. Jilbard's level was driven in this direction from the 20 fathom cross-cut, for a distance of over 300 feet, and the flucan there found to have a width of 41 feet. Still further to the North it has been cut at the surface, beyond Ives's level, but its width in this place was found to be at 30 feet from the surface much diminished.

The deposits of ore are not entirely confined to the primary. Within the sandstone, which at the line of junction is so broken up and irregular, that its stratification can with difficulty be made out, a small seam of ore was cut in the 20 fathom cross-cut from the engine shaft. It has been driven on both ways from the cross-cut to a distance of about 160 feet to the North, and 120 to the South. The upper part of this course of ore is still standing, showing a narrow seam of quartz rich in ore. The level to the North is at present inaccessible: to the South the ore appears to run out at a distance of about fifty feet from the cross-cut.

### *III. History of the Mine.*

This locality has been known for a long period as a place furnishing copper, and was opened to a very limited extent many years since. In 1836 Mr. G. W. Bartholomew made an open cut in a spot where indications of ore were abundant, and the following account of its appearance is given in 1837, by Prof. C. U. Shepard, State Geologist, who saw it at that time:

"The trench has a nearly North and South course, and extends for twenty feet somewhat obliquely across alternations of vertical layers of granite and soft mica slate. The layers of granite are from one to two feet in thickness, while those of the slate are generally much less. It was found on getting below the surface, that the green malachite and brown iron ochre diminished in quantity, and that the rocks were less decomposed. Yellow copper pyrites began to make its appearance in the slate and variegated copper in the granite. The integrity of the rocks and the abundance of the ore increased regularly as the workmen descended, till at the bottom the granite presented several almost continuous veins or layers of ore which in places had a thickness of two inches."—*Report*, p. 47.

Mr. Percival says: "The Bristol Mine is chiefly opened in a large vein of a coarse reddish sub-talcose granite, adjoining which the gneissoid micaceous rock, just referred to, is also sub-talcose or sub-chloritic, with decomposed greenish chloritic seams and nodules, and with more or less copper disseminated."—*Report*, p. 77.

The property subsequently passed into the hands of Mr. A. R. Miller, who drove various shallow levels near the surface, exploring for copper. While in his possession it was visited and reported on by Prof. Silliman, Senior, of Yale College, in 1839, and upon this report, funds to a small amount were obtained

in England for prosecuting the work.* But the adventurers being unable to sustain the enterprise, the explorations were subsequently continued by Mr. L. C. Ives, who erected a small steam engine, and sunk the present engine shaft in the sandstone to the 20 fathom level. During this time, and prior to 1847, considerable shipments of the ore had been made to England, but exactly what quantity we have no means of ascertaining. It appears, however, from the information obtained from the last named proprietor, that it could not have been less than 100 to 125 tons.

It was not, however, until 1846–7, that the mine was opened and worked to any considerable extent. At that time it passed into the hands of Mr. Hezekiah Bradford and his associates. Since that period a large amount of money has been expended here, and over eighteen hundred tons of copper ore have been raised and sold. In 1851 the management of the mine passed into the hands of Mr. Henry H. Sheldon, as agent for the present owners. Mr. Sheldon (who is still the manager) has had the satisfaction of seeing the mine rise from a state of great depression in its affairs and prospects to a condition of prosperity and encouraging profits, with the certainty that by a judicious and moderate outlay, it can be made to return the whole cost of its plant and extraordinary expenses, with a wide margin of profit to the adventure. In addition to this it is our conviction that the hope of future discoveries of great value in the continued exploration of the mine, was never more allied to certainty in any similar enterprise.

The following statement, taken from the books of the mine, shows for what classes of expense the money has been used:

EXPENDITURE AT THE BRISTOL MINE FROM 1846 TO MAY 1ST, 1855.

| | |
|---|---|
| For Land and Leases, | $123,283.94 |
| Buildings, | 16,761.08 |
| Ore Dressing Machinery, | 28,891.77 |
| Mining Machinery, | 28,395.75 |
| Water Power, | 14,821.72 |
| Tools, | 8,999.83 |
| Machine and building for dressing ore by wind, | 8,428.25 |
| Underground labor, | 98,090.77 |
| Dressing ore, (surface men,) | 64,687.25 |
| Underground materials, | 11,330.07 |
| Horses, wagons and carriages, including expenses of stable and hostlers' wages, | 10,080.89 |
| Travelling expenses, | 5,504.85 |
| Fuel, | 9,356.45 |
| Salaries, and unapportioned labor, | 16,559.07 |
| Miscellaneous, | 40,168.78 |
| Total, | $490,810.47 |

From these figures, it appears that, in round numbers, there has been expended for mine and plant, about . . . . . $200,000.00
For mining expenses, including raising and dressing ore, about . 175,000.00
leaving about $115,000, which has been consumed in a variety of ways.

The avails from ore raised to the same date, May 1st, (viz., $186,582 08,) have but little more than covered the actual mining and ore-dressing expenditures. We propose, therefore, having given its geological position, to go into an examination of the mine, its method of working and present condition, with a view to ascertain, as far as possible, what its real value is, and how large a portion of the expenditures which have been made here, may be considered as having been legitimately applied to opening the mine, and how far the excess of expenditure over the receipts may be considered as having been necessitated by the character of the mine itself. We shall also attempt to show that the true nature of the mine was never understood until quite a

* This Report was in confirmation of one made in October, 1838, by Prof. C. U. Shepard, and *which we have never seen.*

recent period,* and that its future success is predicated upon our present knowledge of that character.

*The Ore sold from Bristol Mine* from 1847 up to the first of August, 1855, amounting to 1,811 tons, (of 2,352 lbs.,) is exhibited in the annexed table, drawn from the account sales of the mine.

TABLE OF PRODUCE OF BRISTOL COPPER MINE.

| Year. | Ore Sold. | | Per centage yield of Ore. | | | Average val. pr. ton | Amount received. |
|---|---|---|---|---|---|---|---|
| | Tons. | Pounds. | Highest. | Lowest. | Aver'ge. | | |
| 1847, | 128 | 279 | 50.75 | 21.23 | 41.13 | 137.01 | |
| 1848, | 583 | 837 | 48.00 | 14.78 | 31.76 | 103.15 | |
| 1849, | 365 | 717 | 48.73 | 37.25 | 44.67 | 146.99 | |
| 1850, | 161 | 1950 | 44.20 | 17.18 | 30.80 | 98.56 | |
| 1851, | 49 | 1966 | 19.67 | 15.00 | 17.55 | 48.28 | |
| 1852, | 32 | 646 | 29.80 | 29.37 | 29.58 | 100.50 | |
| 1853, | 135 | 865 | 38.00 | 16.10 | 27.41 | 107.55 | |
| 1854, | 189 | 430 | 38.29 | 21.00 | 27.33 | 136.03 | |
| 1855, (6 m'ths.) | 166 | 781 | 31.55 | 21.26 | 27.00 | 118.84 | |
| Totals. | 1811 | 1415 | 38.57 | 21.46 | 30.80 | | $197,320 |

(To be continued.)

### MINNESOTA MINE.

The latest accounts from the Lake Superior region contain some particulars respecting a new mass, found in the Minnesota mine. It has been stripped for about thirty feet in height, and fifty in length, and is now proved to contain an immense amount of copper. Its average thickness at the foot is more than eighteen inches, and this holds good thus far; they have already uncovered about three or four hundred tons, without disclosing any appearance of running out or even diminishing.

About $1,500 were paid to workmen in October, for cutting up masses of copper, to a size suitable to handle.

The products of the farm, connected with this mine, were for the last year estimated at $9,800, viz: 6,500 bushels of potatoes at $1—3,000 bushels turnips at 50c.—60 tons oats at $30.

### BALL'S ORE CRUSHING MACHINE.

The reports which reach us of the operation of this machine, at the Copper Falls mine, are very favorable.—*Miner.*

### POWDER USED IN LAKE SUPERIOR MINES.

The amount of powder bought in the Ontonagon district last year, was 10,243 kegs of 25 lbs. each. The *Miner* estimates the amount in the other districts at 12,000 kegs more; making in all 22,000 kegs for the year's supply.

### SMELTING WORKS IN TENNESSEE.

Our correspondent, Mr. Alex. Trippel, who has lately been engaged in the erection of copper smelting works, in Polk county, Tennessee, thus speaks of

* It is noteworthy that the State Geologists do not allude to the important fact that this mine is on the line of contact of the two formations.

the difficulties he has encountered: "You cannot conceive what an effort it is to erect a copper smelting establishment in a perfect wilderness, and to make all the fire brick, after having hunted up the materials in all directions · but at last I have succeeded in spite of all prejudices or opposition."

Mr. Trippel was the author of a series of articles on the smelting of lead, and silver, which appeared in these pages in 1854–5. He further says, "You can depend now upon my resuming my pen, and assure your readers that, articles from my hand will speedily follow, not only upon metallurgical operations, but upon the immense mineral wealth which is spread abroad in this county, and especially around my domicil. Indeed there is such an abundance, which is of interest for your Magazine, that it requires the exercise of much judgment to select where to begin."

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### SMELTING WORKS AT CHICAGO.

Land has been purchased in Chicago, for the purpose of erecting a furnace for smelting copper. Every thing is ready for erecting the necessary buildings, and commencing operations in smelting by the opening of navigation.

Also, there is being erected iron smelting works and rolling mills, for working up Lake Superior iron.

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### FURNACES FOR REDUCING LEAD AND COPPER ORES.

A. Jenkins, of Zell, Prussia, has taken out a patent in England, for the following improvements in the above-named furnaces:

The principal feature in the improved reverberatory furnace is, that one fire serves the double purpose of reducing and calcining the ore. The fire is contained in an ordinary fire-place situated at one end of the double furnace. The gases and flame from this fire pass through a lateral opening or flue into the reducing or flowing furnace, and, after passing over the surface of the ore contained therein, enter by another opening or openings into the calcining furnace, which is placed upon the same level, or nearly so, with the flowing furnace, the gases passing off by a suitable flue or flues to the chimney. In the passage or passages which conduct from the flowing furnace to the calcining furnace, there are placed suitable doors or dampers, which are so arranged that by opening or closing certain of them, the gases or flame may either be directed into the calcining furnace, or cut off and turned into a waste flue leading to the chimney.

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### ONTONAGON.

Few people, comparatively speaking, even in our own State, are aware of the rapid growth and increasing importance of that portion of Michigan, denominated the "Upper Peninsula." But a few years have passed since the entire Lake Superior region was a wilderness, and unsettled by any human being save the red man, unless, indeed, we except a few missionaries and the voyageurs and trappers who traversed its waters for the purpose of trapping the rich furs inhabiting the country contiguous to its shores.

The known existence of valuable mineral, together with the perseverance and industry of the American people, have wrought great changes in what was so few years ago deemed a valueless portion of our State. Instead of the rude batteau of the voyageur, we behold the first class steamers navigating our Lake, freighted with pleasure seekers and business men from all parts of the world; and in lieu of the rude wigwam of the Indian scattered promiscuously

along her shore, we see, as it were by magic, towns springing into existence, denoting by their business appearance the march of civilization.

Ontonagon, owing to her peculiar situation, has become the largest and most important town on the entire Lake, containing at the present time over 1,800 inhabitants, which population would undoubtedly have been much larger but for the difficulty of obtaining a good title to lands here, as all the real estate embraced within the present town site is in litigation. But we think the same causes will prove no drawback to our progress another year, as we have good reason to believe the legal questions involved will be decided by the proper authorities during the coming winter.

The town is pleasantly situated and borders upon Lake Superior and the Ontonagon River, about 10 feet above their level, and to the eye of the traveller presents an air of beauty and business, far superior to its years. As late as 1850 the first frame house was erected, and only two were built that season, since which time the number has increased to over two hundred, among which are many buildings that would prove an ornament to towns of a far older growth. The streets and lots are very regularly laid out, the former 66 feet wide and the latter 50 by 100 feet. There is a public square containing 2 acres, and also a levee belonging to the town and bordering upon the river, of 700 feet in length, upon which a considerable improvement has already been made by piling and grading.

The Ontonagon River, which bounds the business and thickly settled portion of the town, on the south, is a stream varying in width from 600 to 800 feet, and contains sufficient water for floating all Lake steamers for full one mile above its mouth. It is navigated by flat boats for twenty miles, and all the mines situated within its vicinity receive the greater portion of their supplies, and ship their copper by this means. Quite an extensive business is being carried on in this way, and we consider it no under estimate to say that over 100 men obtain a living from this source alone, to say nothing of the lumbermen and others, employed along the shores. In addition to other facilities there has been added the present season a small steamer, which makes regular daily trips to the American Landing, a distance of ten miles.

With a small appropriation from the General Government we would have one of the best harbors on the Lakes, as, with the exception of the bar at the mouth of the River, there is sufficient water to float the largest craft that navigate the western waters.

The great disadvantages arising from the want of a proper harbor, are, to a certain extent, obviated during calm weather by a pier running into the Lake for a distance of over 1,600 feet, owned and built by Carson and Close, at an expense exceeding $20,000. A very large majority of the freight received at this port is first landed on this dock, and for the year 1854 exceeded 50,000 bbls. bulk.

There are other improvements progressing and in contemplation of which, time and space in our present number will not allow us to speak, but to which we shall refer in future. That Ontonagon is destined to become a large and important town, and that speedily, no one conversant with its situation can deny. Blessed with one of the most healthy climates in the world, a rich mineral and agricultural country surrounding it, and shipping the present season over $800,000, as the products of her mines, which are still in their infancy, what will prevent her when the mineral resources of the country shall have been more fully developed, from becoming the Cornwall of America.—*Lake Superior Miner.*

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PRODUCE OF LAKE SUPERIOR MINES IN 1855.

In one of the Chicago papers, we find some statements of the yield of the Lake Superior Mines, during this year, which are worthy of notice:—

We had a call yesterday from Samuel W. Hill, Esq. Geologist and Min-

ing Engineer, from Eagle Harbor, Lake Superior, from whom we learn that the mining business has been prosperous during the past season. He had previous to leaving Lake Superior, visited all the mines, and learned what their shipments have been, and also how much they will send forward before the close of navigation. The total shipments will be as follows. From the

*Ontonagon District.*

| | | |
|---|---|---|
| Minnesota Mine | 1,350 | tons. |
| Norwich | 200 | do |
| Rockland | 170 | do |
| National | 80 | do |
| Forest | 100 | do |
| Nebraska | 20 | do |
| Windsor | 88 | do |
| Toltec | 85 | do |
| Adventure | 80 | do |
| Ohio Trap Rock | 15 | do |
| Aztec | 10 | do |
| Ohio | 5 | do |
| Merchants | 3 | do |
| Ridge | 37 | do |
| Douglas Houghton | 80 | do |
| Total from the Ontonagon District, | 2,176 | do |

*Portage Lake District.*

| | | |
|---|---|---|
| Isle Royale Mine | 245 | tons. |
| Portage | 48 | do |
| Huron | 10 | do |
| Albion | 15 | do |
| Pewabic | 17½ | do |
| Quincy | 10 | do |
| Total from Portage Lake District | 345½ | do |

*Keweenaw Point District.*

| | | |
|---|---|---|
| Cliff Mine | 1,600 | tons. |
| North American | 250 | do |
| Copper Falls | 90 | do |
| North Western | 90 | do |
| North West | 125 | do |
| Phenix | 5 | do |
| Native Copper | 2 | do |
| Summit | 4 | do |
| Star | 5 | do |
| Central | 48 | do |
| Eagle River | 3 | do |
| Fulton | 2 | do |
| Total Keweenaw Point District | 2,234 | do |

It will be seen that the product of the mines for the past year has been, 4,755½ tons. In all the districts several other mines are in process of development, and they are worked to some extent; but those named above are all from which shipments will be made during the present season.

The value of the copper at the wharves on Lake Superior, is $440 per ton. This makes the entire products of the mines for the past year, $2,004,700. Mr. Hill after carefully figuring up the cost of the mining operations for the season, esimates the net profit of all the mines to be, $240,000. This far exceeds the profits of any previous year. Many of the mines have expended much more than their receipts, and the profits above named will be divided among a few of the more productive companies. Many of the mines which have shipped comparatively small quantities during the past season, will make much larger shipments next year. Mr. Hill estimates the increase at 1,200 tons, or nearly 25 per cent. on this year's shipments. The increase this year over the last has been 1,800 tons.

Last year on the breaking out of the Russian war, France sent one of her savans—Mons. Rivot,* Prof. of the School of Mines—to this country to see whether she could obtain her supplies of copper here. She had previously obtained her supplies in Russia, and of course that source would be cut off. The Professor returned, taking with him several tons, and satisfied that the Lake Superior region could furnish an abundant supply. The American copper was carefully tested, and found fully equal if not superior to the Russian, and very far superior to the English. It is used in the manufacture of ordnance, and no inconsiderable quantities are consumed in the manufacture of jewelry, percussion caps, and a great variety of other articles. The superior tenacity of American copper is a very strong recommendation in its favor.

It is also largely alloyed with silver, In the poorest quality of copper taken from Copper Falls Mine, A. A. Hays, State Assayer for the State of Massachusetts, found in a ton $3\frac{3}{4}$ lbs. of silver This fact renders it a superior article for sheeting vessels, as the silver prevents oxydization.

Of the copper shipped from Lake Superior about 1,500 tons goes to Pittsburg, 2,000 tons to Detroit, and the balance to Cleveland and Boston.

With regard to the above estimates, the Lake Superior Miner makes the following remarks:—

The above estimates, as far as the Ontonagon District is concerned, are only approximative. The Rockland is 40 tons too high, the Forest probably 80 too low. Several others are somewhat too low, while the Evergreen Bluff, Flint Steel, and smaller mines which have shipped are not mentioned at all. If the statement is intended to include copper raised during the year, it is considerably too low in the aggregate.

The Minnesota Mine sold a considerable amount of their last year's copper, to the Rothschilds of Europe. It was smelted in Paris, and it is a curious fact, that it was found to contain besides the usual alloy of silver, a *trace* of *gold.*

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## QUARRIES AND CLAYS.

### DORCHESTER STONE.

Some of our readers may have noticed a drab colored free stone, recently introduced into this city, and used for the construction of the Mechanics' Bank in Wall street, the Historical Society's Library, in Second Avenue, and various houses and stores in Park Place and other streets. This stone comes from the parish of Dorchester, in the province of New Brunswick, at the head of the Bay of Fundy.

It is used to some extent in chemical works for stone tanks, being found sufficiently free from iron to withstand the effects of alum for any length of time. Neither does it appear to be affected by the action of frost, or by exposure to the weather.

The following is an analysis of a piece of this stone, made by Dr. Chilton.

* We have a copy of Prof. Rivot's Report of his visit to the Lake Superior Region, and commence its publication in the present number of the Mining Magazine.—[Ed.

I have analyzed a specimen of light-colored sandstone, and find it to contain the following:

| | |
|---|---|
| Silica, | 82.52 |
| Alumina, | 7.07 |
| Protoxide of iron, | 2.51 |
| Peroxide of iron, | 1.04 |
| Lime, | 1.83 |
| Magnesia, | 1.42 |
| Oxide of manganese, Potassa, | traces. |
| Water and loss, | 3.61 |
| | 100.00 |

There is nothing objectionable in the composition of this stone. Judging from this, as well as from the experiments which I have been enabled to make upon it, to test its power of resisting the action of frost, I consider it a valuable building stone.

The following is a description of the locality:

The Dorchester Manufacturing Company was organized some time since to work an extensive deposit of drab colored free-stone in the parish of Dorchester, at the head of the Bay of Fundy.

The stone beds extend fully three miles in length, on a peninsula, formed by the Petitcodiac and Memramcook rivers, similar to that part of Manhattan Island, on which the city of New York stands; the former being represented by the Hudson, and the latter by the East river. These rivers are the boundaries of the Company's property, on the east and west; and, with one or two unimportant exceptions, the whole point of the peninsula, comprising between three and four thousand acres, is owned by the Company, either in fee simple or on long leases.

The stone, laying in nearly horizontal layers of various thicknesses, from five or six feet down to three or four inches, is covered with only a few inches of soil, so that to prepare quarries for furnishing large blocks, as well as platforms and flagging of any dimension, will be comparatively an inexpensive operation.

The present quarries are opened at somewhat less than a mile from the river Petitcodiac, and just sufficiently above it to afford an excellent opportunity of building a railway from the quarries to the wharf, on which the loaded cars going down will take back the empty ones. Advantage has, also, been taken of a natural creek, on which to build the wharfs, where vessels of any size can load, secure from every wind.

THE

# MINING MAGAZINE:

DEVOTED TO

## Mines, Mining Operations, Metallurgy, &c., &c.

VOL. VI.—FEBRUARY, 1856.—No. II.

ART I.—VISIT TO THE LAKE SUPERIOR REGION, IN 1854.*—By Prof. E. Rivot, of the French School of Mines. No. 2.

[Continued from page 37.—Vol. VI.]

### GEOGRAPHY.

I shall offer a few particulars relative to the Geography of Lake Superior, which is sufficiently shown upon the chart of Messrs. Foster & Whitney. The two promontories (Gros Cap and Iroquois Point) form the pillars of Hercules of this great lake, and mark the mouth of the St. Mary's River. Upon the south shore, belonging to the United States, the points worthy of notice are the following:—

The promontory of White Fish Point, with its terraces of sand or gravel and alluvium; the bold shore of red and white sandstone near Grand Island, to which the streaked appearance resulting from the alternate beds of sandstone of different colors has given the name of the Pictured Rocks; the bay of Chocolate River, near which are found immense deposits of iron ore, which are worked with much enterprise; the tongue of land called Keweenaw Point, which is separated almost entirely from the main land by Portage Lake; the Porcupine Mountains, west of the river Ontonagon, and, in short, the numerous islands around Point Detour, the principal port of which has been the seat of an old mission of the Jesuits.

All the western portion from the head of the lake to the English boundary, which commences at Pigeon River, has hardly been explored. It belongs to the territory of Minnesota, and the treatics with the Indians for the surrender of the territory date only from 1854.

The northern side is more broken than the American shore. It presents a great number of islands, vast bogs, and lofty mountains which approach to the lake.

*Translated for the Mining Magazine.—Copyright secured.

On the east the coast affords only open harbors, in which vessels cannot obtain any protection from the tempests.

Two of the islands are worthy of special mention, viz., Michipicoten and Isle Royale. Both are marked on the ancient chart of the Jesuit Fathers, and reported by them, in accordance with the Indian traditions, to be very rich in native copper. This has not been confirmed by recent explorations, for the works upon Michipicoten are almost entirely abandoned, and Isle Royale produces annually not more than 40 tons of copper.*

Isle Royale is a portion of the State of Michigan. It is in range with Keweenaw Point, and presents with it, some grand analogies of geological constitution. It has deep and well sheltered bays, capacious and safe harbors at its extremities and south side, whilst on the north the shore is somewhat broken, and presents a bold wall.

Many veins containing copper ores, copper and native silver, have been proved on both the American and English shore, and the islands above mentioned. Nevertheless, mining operations are concentrated at Keweenaw Point and Ontonagon. These are the two localities of Lake Superior which at this time manifest the greatest enterprise, which are the most important to visit, and which I shall specially describe.

It is interesting to notice the position of the villages and towns on the south shore of the lake, at a distance of eight hundred to a thousand kilometres from Detroit, which is the nearest city. Following the shore from east to west, and beginning at Keweenaw Point, we pass successively the following ports and villages: Copper Harbor, Agate Harbor, Eagle Harbor, Eagle River, Portage, Elm and Misery River, Ontonagon, Pewabic and Le Point.

Copper Harbor is large, well sheltered from the north, northwest and north-east winds, which often blow with almost inconceivable violence. Its entrance is marked by a harbor, the light of which can be seen, at night, from six to seven kilometres.† Opposite the entrance is Fort Wilkins, which was built in 1844 by a detachment of U. S. troops, who were sent to protect the Americans from the Indians. It is now abandoned, as the red men have left the country. A little village has been built at the foot of the harbor, which will become very important in a short time, if the veins in the neighborhood become the seat of active mining operations.

Copper Harbor is now the only inhabited port on all the coast, from *La Pointe*, in which vessels can find a shelter from the tempest. It has, consequently, the advantage of a very regular

* This was said of Isle Royale more than a year ago. The only mine in Michipicoten was suspended about the time these observations were made.

† Kilometre—1000 metres—the metre 39 inches.

communication with Sault St. Marie during all the period of navigation, which continues from May to the end of November.

The bay of Agate Harbor will become a very beautiful port. Its entrance is easy, and its waters deep, even to the shore, in its whole extent. Oftentimes, heretofore, vessels have sought refuge there in violent storms, and disembarked their passengers without difficulty. The virgin forests here approach close to the borders of the lake. A clearing has been commenced by an American Company, but what they have done as yet is unimportant.

The exploration of many veins of copper has been commenced at a short distance from the harbor, and if the works are pushed with activity and rendered profitable, a village will soon grow up here which will be a rival to those of Eagle Harbor and Eagle River. In a country where the price of labor is so high, and under a climate rough as that of Lake Superior, the clearing of fertile land is not sufficient to attract settlers; the active mining operations alone can create a village here.

Thus we see the two only real harbors on the south shore of Lake Superior, Copper Harbor and Agate Harbor; the former scarcely inhabited, and the latter completely deserted, while very flourishing villages are located at Eagle Harbor and Ontonagon, places where vessels are exposed to all the fury of the tempests. The aspect presented by the settlements on the shore indicates at once the importance of the mining operations in the vicinity.

The port of Eagle Harbor is small, and badly sheltered from the north wind. An important village already exists there, which owes its rapid growth to the mining operations carried on at the Copper Falls, North-western, North-west, and other mines.

The village of Eagle Harbor is built on the shore of the lake, at the mouth of Eagle River. It has more than a thousand inhabitants, and is daily rising in importance. It is the depot for the rich mines, Cliff and North American. The river is not navigable, and the coast offers no shelter to vessels. They load and unload at a pier, constructed of piles; thus, when the winds raise the waves of the lake, vessels are compelled to cast loose, and seek shelter at Copper Harbor, or westward at La Pointe. Woe to the vessels which do not make sufficient despatch. They are cast ashore, and with great difficulty got afloat again. The wooden pier is very often destroyed by the waves. This was the case during my visit, on the 3d of October, 1854, during a blow which lasted for two days. The consequences to Eagle River from this exposed position are, great irregularity of communication with Sault St. Marie during the whole season. The miners cannot reckon with certainty upon the arrivals and departures, except in the months of June, July, August and September. This unfavorable circumstance is, however, largely compensated for by the unusual richness of the veins worked by the Cliff and North American companies.

Portage, Elm, Misery River, &c., are little villages situated under the same unfavorable circumstances as Eagle River, and corresponding to mines which are not worked with much activity.

The village of Ontonagon, built at the mouth of a river of the same name, is the most important on Lake Superior Its population exceeds fifteen hundred, and many houses already possess that degree of comfort so rare in new countries.

The river is navigable for flat boats, south of the village about thirty kilometres, but this navigation is dangerous on account of the numerous rapids. A bar at the mouth of the river prevents the entrance of vessels above a certain tonnage, and the coast offers no shelter in which they can seek refuge. They are obliged to load and unload, as at Eagle River, upon a wooden pier, which extends into the lake more than two hundred metres (600 feet). The importance of the village of Ontonagon, arising from the numerous mines at work in the vicinity, would be soon increased, if the proposition for a railroad, of which I have already spoken, should be put in execution.

I had no occasion to visit La Pointe, that old mission of the Jesuits, the harbor of which constantly serves to shelter vessels from the tempests of the lake.

## CLIMATE OF LAKE SUPERIOR.

The climate of Lake Superior is very severe during the winter. This season commences in the month of October, and does not terminate until near May. During many months the thermometer is below 20° Centigrade, and during blows of the wind from the north, it sinks to the freezing point of mercury. The waters of the Lake form ice of great thickness, which is often broken up by the tempests, and it becomes piled up on the shore mountain high. Snow covers the ground for months, and enables the inhabitants to go great distances on snowshoes. All travelling is impossible except upon the routes already opened.

The spring is very short; it continues scarcely a month, and is accompanied by violent tempests which render the navigation extremely dangerous. The melting of the snow and the fall of trees often prevents the communication from one village to another by land.

During summer (the latter part of June, July, and the earlier part of August) the sun acquires great force. The heat is sometimes insupportable near mid-day, but the nights are almost always cool. The mosquitoes and black flies wage an angry warfare against man and animals; the black flies disappear in the month of August, but the mosquitoes persevere to the end of September.

Autumn is, on Lake Superior, as also throughout all North America. the most delightful season of the year. The days are

charming, and the warmth very agreeable during all September. The nights grow cooler and cooler, and sometimes the thermometer descends to zero. In the month of October, the close of autumn is marked by terrible tempests and floods of rain, to which snow soon follows. Navigation can be continued to the end of October and into November, but it is irregular and dangerous; the steamboats can seldom then touch at Ontonagon or Eagle Harbor, in consequence of the lack of shelter.

### VEGETATION.

All the country is covered with primeval forests, in which the clearings advance slowly. The pine tree prevails in the higher parts, and almost every where displays its sombre foliage above the birch, the ash, the maple, &c., which abound in the vales. The soil appears to be very fertile over a large part of the country, and even now many mining companies have commenced clearing and cultivating with success, rye, potatoes, beets, and various kinds of beans.

Almost all the necessaries of life, such as flour, meal, eggs, potatoes, are brought by steamboat from Cleveland, Detroit, and even Chicago. Grass is entirely wanting in the forests, and no artificial meadows have been made, hence the support of horses and sheep is very difficult.

The forests contain very little game. The only animals occasionally seen are the gray squirrels. During winter one can hunt eagles, wolves, and bears.

In climate, Lake Superior resembles very much the centre of Sweden, although the latitude is nearly that of the north of France. The average temperature of Copper Harbor is from 41° to 45° Fahrenheit, or + 5° 25' Centigrade.

### CHANGE OF LEVEL IN THE WATERS OF THE LAKE.

The great lakes of North America have no sensible tides, but their level undergoes gentle or sudden variations, some particulars respecting which may be of interest.

In the violent storms during which the wind blows from the same quarter for two or three days, the level of the water is raised more than three feet above its usual height, and gradually falls as the pressure of the wind declines. This elevation cannot be proved on the unsheltered sides, because of the height of the enormous waves which roll on the shore, or dash against the rocks; but it is easy to observe it in the harbors and deep bays, where the water remains scarcely agitated. I witnessed this phenomenon at Copper Harbor, October 3d, 1854; after a blow from the north-east to the north-west; the level of the water was raised more than three feet at the dock in the harbor. The in-

habitants assured me that in the most violent storms the water rose more than six feet under the effect of the wind.

I observed the same circumstance on Lake Huron, when, on board the steamboat Illinois, we were aground near the light-house of Thunder Bay during a gale of wind; after two days the vessel floated in consequence of the rapid rise of the level of the water and of the action of the wind upon its hull.

I have not been able to learn that on the side of the lake from which the wind blows, there is any corresponding fall in the level of the water; which is an important fact, as it would prove that the phenomenon is general, and not confined to particular localities under the action of the wind.

The Jesuit Missionaries, and all other persons who have resided any length of time on the shores of the great lakes, have described a phenomenon which has not, even to the present time, been satisfactorily accounted for,—the sudden and instantaneous change in the level of the water along the shores, in times of a perfect calm. Two or three waves, of the height of six or more feet suddenly form at a distance from the shore, and rolling towards it dash against the rocks, or overflow large tracts of land. This fact is stated as occurring on the Lakes Erie, Huron, Michigan, and Superior, by the Jesuit Missionaries, by Gov. Clinton, General Cass, Professor Mather, Foster, and Whitney, and by many old inhabitants of Saut Ste Marie. It is therefore to be regarded as perfectly established, although no sufficient explanation has been given of its cause.

A full description of all the particulars in relation to it will be found in Foster and Whitney's Report. I shall notice only those observations which appear to be the most striking, without entering into any details.

Governor Clinton states that on the 30th of May, 1823, when the sky was clear and there was a perfect calm, and a few minutes after sunset, three waves, of three metres or more in height, were seen to wash up against the shore and quickly retire, the whole distance from Otter to Kettle Creek on the English side of Lake Erie.

At Saut Ste Marie the river is wide, exceeding 1,600 metres, and the depth of the water on the rapids about Om. 85 (over two feet). In the summer of 1834, the water was seen to recede entirely and leave the rocks bare throughout the channel; for an hour the inhabitants were able to go out and take the fish left in the pools between the rocks. The water then suddenly returned in one vast and furious wave, before which the people had scarcely time to save themselves by flight. The same phenomenon was repeated twice during the same day, at the close of the month of April, 1842, when there was a perfect calm.

At Lake Superior, Messrs. Foster and Whitney have often observed vast waves advance to the shore when the surface was

perfectly calm, and the breeze hardly perceptible; immediately afterwards the water of the lake has resumed its previous tranquillity. After these sudden changes of level these two geologists always noticed most violent tempests to follow, which led them to think that sudden changes in the atmospheric pressure are not entirely without influence on this phenomenon. It is, however, difficult to conceive how a partial decrease in the atmospheric pressure should be sufficient to cause an elevation of the water three metres above its level.

In those lakes which communicate with each other, annual and periodical changes in the level of their waters are observed. This can be explained by difference in the relative quantity of rain which has fallen at the North or South. The climate of Lake Superior is very different from that of Lake Erie; so that the summer season can be dry at the one and wet at the other.

The full investigation of these phenomena would be of considerable scientific interest. It cannot be seriously undertaken until some future and distant day, when the shores of the lakes shall be inhabited, and regular and complete observations have been taken.

## MIRAGE.

Throughout the summer, when the atmosphere is not disturbed by violent winds, the air acquires a very different temperature over the earth, which is warmed by the heat of the sun, from that over the water, which remains always quite cool. These differences occasion great refraction, which is a cause of much embarrassment to astronomical observations, and produces the singular effects of mirage.

We can explain, by atmospheric refraction, a singular phenomenon of which I was a witness, October 16th, 1854, at the entrance of St. Mary's River. At the moment when the sun was about to set, his rays fell upon a snow squall, and displayed an elliptical arch in the sky which was perfectly defined. The proportion of the larger, or vertical axis to the smaller, or horizontal one, was as 5 : 3. The appearance of the arch in the sky continued many minutes, and was observed by all the passengers.

The Aurora Borealis is very frequent during the winter, although it is not rare in summer. However, it is not so brilliant nor well defined in the latter season.

## GEOLOGICAL ARRANGEMENT OF THE STRATA OF LAKE SUPERIOR.

The chart of the whole of Lake Superior, published in 1850, by Messrs. Foster and Whitney, and the chart of parts, have been prepared on the basis of the explorations made in the consecutive years 1847, 1848, 1849.

It is a matter of astonishment, that such a short period of time has been sufficient for these geologists, charged by the government with this important enterprise, to lay down precisely the limits of the strata, and to show very exactly the zones, within the limits of which, the deposits of copper are to be found.

We should take into consideration the almost insurmountable difficulties which are met with, at every step, in a country covered with the primeval forests, and in which the temperature at times during winter sinks down to the freezing point of mercury. Those districts near the coasts and settlements at the mines could be explored with comparatively great facility; but in the interior, at a distance from inhabitants, it is not possible to make any excursion, unless very short ones, and then they are attended with much hardship.

In addition, the strata almost every where are covered by a great thickness of vegetable soil, and by alluvium, the thickness of which often exceeds twenty metres (60 feet). The character of the rocks is not apparent, or exposed, except on the summits of the mountains, or the banks of certain rivers which ow through deep valleys.

Similar circumstances exist without doubt in most countries in Europe as well as America; but at Lake Superior they become much more embarrassing, in consequence of the difficulty of living in uninhabited forests.

Those portions of the lake shore best known are Keweenaw Point, the Ontonagon region, and Isle Royale; in the two first, the mines are in very active operation and some yielding considerable profits.

Isle Royale has now almost entirely lost the importance given to it in the reports of the travellers at the commencement of the mining enterprise. Of all the works opened in five or six years, there remains only two mines at work. The consequence is, that excursions can be, the most easily and profitably, made to Keweenaw Point and Ontonagon.

In order to set forth as clearly as possible the arrangement of the strata, I shall first describe different parts of the country, and then speak of the different rocks and the alluvium which form them; an extensive subject of interesting investigation.

(To be continued.)

## Art II.—SOME REMARKS ON COAL MINING.—By J. Marlor.

[Continued from page 420, Vol. V.]

In working coal mines, especially those which have a steep inclination, which prevents the driving out in any direction except by levels, an organized plan must be adopted. The principal roads must be transverse to the rise and dip of the mine; and these roads should be driven to the boundary of the concern, or as far as may be considered the proper distance, according as circumstances may require, and presuming that all the bearings of the case have been duly considered, both for the present and future proceedings of the work.

In the north of England the mines lie at a very gentle inclination, which enables them to drive out in almost any direction, and by doing so, there are too many roads to ventilate, the doors and crossings are numerous, and where it is so, the air is divided accordingly. Hollows or goaves are formed, where there should be solid coal, and the attempt to properly ventilate these, if they cannot be inspected, is still worse. If, however, this can be accomplished, coal must be left to support the roof of the mine, and thus it has to be worked twice over, which cannot be right. The roof of the mine, of the strongest kind, will probably fall down where there is a large area of the coal got out; the floor will rise up considerably, when the superincumbent pressure is taken off, by removing the coal, and ultimately the roof and floor of the mine will come together, consolidating very closely in places where all the coals have been cleared out, and thus all ventilation must cease. There have been instances where it has been necessary to cut through the broken strata, where the coal has been got a few years previously, and it was almost as difficult to do this, as if it had never been disturbed.

In making any remarks respecting the ventilation and working the mines in the North of England, I wish it to be understood that I do so with the most cordial and friendly disposition; and whatever is said respecting their plans of getting coal and of ventilation, I have no object in view but that of improvement, and greater safety to the men.

In the year 1812, I was at Newcastle upon Tyne. I was then young; but young as I was, I considered that they were much behind the Lancashire Collieries in point of construction and efficiency, and in that ease and convenience with which work of a similar kind was done at the Oldham Collieries. I certainly admired the great quantity of work which they got through, and the persevering industry which they manifested in all their proceedings; but the same amount of work could have been done with much more ease, and at less expense, if it had been wrought

on the Oldham plan, with tubs and wheels, instead of the clumsy corves, made of sticks and without wheels. The Lancashire tools are also better adapted to the purposes wanted, are more easily wielded, and the work can be done with much less exertion, than their heavy picks require, having no steel in them.

At the period to which I have referred, I remember being at a pit called the Percy Main, where there were two banksmen, and two horses to take away the coals from the pit's mouth to the screens. If there had been tubs with wheels on them, such as are used in the Oldham Collieries, the two men would have removed the coals with more ease, *without* the horses, than they did *with* the horses to assist them.

In the North of England, there are perhaps the most extensive collieries in the world, and there are more coals obtained in the two counties of Northumberland and Durham, than in any other part of Great Britain of the same area. An immense quantity of coals are raised, and sent by sea and railway to many seaport and inland towns in the kingdom, and to many places on the continent of Europe, as well as to some of the colonies. There is such an abundance of coal, and the colleries are so numerous and extensive, that there must be a great variety of plans and constructions made use of, to overcome the varied difficulties which present themselves in the working of the mines; and much ingenuity and perseverance are unquestionably manifested in their undertakings. According to Mr. Dunn's statement, in his Descriptive View of the Coal Trade, page 61, some of the North of England Collieries began to use tubs with wheels on them, and to have conductors and cages in the pits, in the year 1836. From this date, I consider that the colliers there began to proceed upon a better principle for doing their work, and also with greater despatch, more ease, and much greater safety. They then began to work upon the principle which has been in operation in the neighborhood of Oldham for the last 55 or 60 years; and I must do them the justice to say, that the North of England colliers now see that it is possible they may have been in error in some respects, in the mode in which they had previously worked their mines. I would venture to compare them with what has been said of the Scotch farmers, who, 50 or 60 years ago, plodded on in the old way in which their fathers had done before them, in the cultivation of the soil. At length a few enterprising individuals, who were not trammelled by prejudice and old customs, and who suspected that some improvement might be made in the old beaten track, and a better system adopted; at once, and fearless of ridicule, proceeded to act accordingly. When their neighbors saw the superior crops of produce raised by the new mode of farming, the scales it is said began to fall from their eyes, and thus, ultimately, the improved system of farming which is now generally adopted came into notice, and the Scotch justly rank as the first agriculturists in Britain.

There are, I am assured, spirited proprietors of coal in the north, who will see the necessity of leaving the old track, and adopting a better and safer system in every respect. It is a mistake to suppose, that because a pit is a great depth from the surface, that there are therefore greater difficulties to contend with on this account. This is not exactly the case; in many instances it will certainly take more money and a longer time to sink deep pits, but if there is engine power sufficient, and not much water to be removed, the difficulty will be inconsiderable. I do not see that the regular routine of working the mine should be more expensive, in pits of 300 or 400 yards in depth, than in those of 150 or 200 yards. Of course there may be exceptions, but these do not often occur; they are therefore exceptions—not the rule.

It may be said there is more danger in deep pits, than in those which are not considered to be so; but if the tackling is good, it is evident that the extra danger is more in the imagination than any thing else; because if a person fall down a pit of 150 or 200 yards in depth, it will be as fatal as falling down one of 400 yards deep. Some people say, that there is more danger in the bottom work, with regard to the roof falling: this however is a mistake; indeed, I do not think there is any extra danger at all in this respect, as the roof is in general stronger on the deep than on the crop of the mine. It is also the general opinion, that there is much more danger with regard to inflammable gas in deep pits; in many instances this is true, although there are exceptions even to this. That there is danger in deep pits cannot be questioned, as there are so many fatal explosions on record. In many of the explosions which have taken place in different parts of the kingdom, various circumstances require to be taken into consideration in reference to them. The men, or some of them, may not have carried out the instructions given to them as they ought to have done; but whatever may have been the cause, I wish to suggest such means as may, with proper attention, prevent explosions altogether. I must again take the liberty of saying, that I am at issue with the North of England plan of ventilation, and also with the plan of working their mines generally adopted. The pillar and stall system is not good, and the ventilation has to correspond with it. The coal is cut up into too many divisions and crossings, and the result is that an unnecessary number of doors are required for these crossings; there is also too much frontier in their workings, in some cases one half more than is required. The working department should be more concentrated; the men should work two or three together in one work, and even more in particular cases; thus the works would be sooner finished, the props would be less broken, where the coal is got out quickly, and there will be less loss of coal in the working of the mine. There should be no hollows or goaves except at the extreme workings; nor should the air be split into more than three or four divisions, if possible, so that the area of the roads in which it is

divided, should not be less than that of the up-cast pit. Again, let the volume of air sweep up to the old hollows or goaves; and bring back all the coal at once as the work proceeds. If possible, old hollows or goaves should be connected with a pit on the rise of the mine, in order to allow the gas to escape as it is produced in the old workings. If these suggestions for working a mine were fully carried out, I think explosions in coal mines would be very rare indeed; and if one should happen, there is reason to believe it would not be very serious.

Some of the plans which I have ventured to recommend are now in operation in some parts of Lancashire, where there are pits as deep as many in the North of England, and in which also there is probably as much inflammable gas to deal with as in their pits. There certainly have been destructive explosions in Lancashire, but I am not aware of any by which all the men in the pit have been killed. I ought to say that I refer to Lancashire in a limited sense. I would be understood not to exceed ten or twelve miles around Manchester; because there are collieries at Wigan, St. Helens, Prescott, and other places, at several of which they use corves made of sticks and without wheels; and I have generally observed, that where such materials are used, it may be considered a marked indication of prejudice and resistance to improvement. At all these places females worked in the bottom before Lord Ashley's act was passed in the year 1843; and where this was the case, wages were in general much lower, and little or no improvement could be expected.

In the neighborhood of Oldham, the men work two or three in a place: they in general agree to work together, when they are equally paired. I am aware that where men have not been accustomed to do this, it will not be very agreeable to many; but if the supply of coals that is wanted is obtained, where is the difference? If there be less danger of explosions by this mode, surely greater safety is more than equivalent to any inconvenience it may occasion. The safety lamp is not so convenient, nor does it give so good a light as the common candle; but notwithstanding this, the lamp has to be used, and the men are willing to use it where there is much danger.

The whole philosophy of working coal mines upon the best principle, may be expressed in a very few words. It is simply, not to get any coal so as to form hollows or goaves until the roads or levels are driven out to the boundary of the mine, or as far as may be considered the proper distance to drive. Let the men work together, and have as little frontier in working the mine as possible; get the coal out in the works quickly; let there be as few divisions of the air as possible, and the area of the roads in which it travels should not be less than the area of the up-cast pit. Have an old pit on the rise of the mine connected with the old hollows or goaves, to allow the gas to escape as it is formed in the

old workings. If these simple suggestions were carried out in all their bearings, I am of opinion there would be fewer explosions in coal mines; and if one should occur, it would not be so destructive as many have been.

Whether it is the best plan to get the coal on the rise, or on the deep of the mine, in the opening of a new colliery, is a matter of opinion with some persons; but it may be a question of necessity in some cases to get the coal on the deep, and in other cases to get it on the rise first. The practical man can readily tell which is the more desirable plan to adopt according to the varied circumstances of the case.

On opening a pit, it is usual to drive a pair of levels on each side of the shaft; one of these levels is called the wagon road, and the other the counter level. The counter level answers no purpose except for the ventilation. The air goes from the shaft along one of these levels, and returns by the other, or it is conveyed to the different places where it is required, and ultimately it ascends the up-cast pit to the surface. This is the common mode of proceeding in opening coal mines. There is one wagon road on each side of the pit by which all the coals are brought to the shaft; and of course there is one counter level also on each side, while other roads branch out of the wagon roads: one side is called the North, the other the South side of the pit.

Where pits are of great depth, the water is in many cases "stopped" or "tubbed" out, as it is called in the North of England. This is done by putting in segments of cast iron, which tally with the diameter of the pit. These segments are well jammed at the back part, and the front is wedged up with wooden wedges until the water is completely stopped. Sometimes the tubbing is accomplished with strong segments of wood, and generally with success; but of course it is an expensive undertaking, whether it be done with wood or cast iron.

This tubbing or stopping is not often resorted to in pits of shallow depths, say of about 100 or 150 yards deep, and for this reason: suppose there were a spring of water to be stopped, at 100 yards from the surface, and the distance from the surface to the coal were only 150 yards, it is possible, if the water were stopped out at this depth, that when a large area of the coal had been got—the mine being four or five feet thick—the roof would be affected or broken up as high as the spring which had been tubbed, and which, as I have said, was only about 50 yards above the coal. In such a case, the water would trickle through the loosened strata, and thus the expense of tubbing would be thrown away, as it would now have to be pumped from the bottom of the pit the same as if nothing had previously been done to stop it back. If a pit is 300 or 400 yards deep, and a large spring of water has been met with at 100 or 150 yards from the surface,

and stopped out, the probability is that the strata would not be affected by the getting of the coal at 200 or 250 yards below it, so as to allow the water to pass; and where this is the case, it is well to stop it out, as it will be much cheaper to do so than to pump it, perhaps as long as the works may continue. This is a plan however, as I have said, more immediately adapted for deep pits, in which there are springs of water, in the first 100 or 150 yards from the surface, than for those which are nearer, or not more than 100 or 150 yards to the coal. I believe it is adopted in the North of England, and it is certainly right to stop out water where it is not likely to be affected by the workings below, and in such cases I should recommend it, especially if it will not be very expensive.

A pit on the extreme rise of the strata, to allow the inflammable gas to escape as it is evolved in the workings below, being in some degree connected with the ventilation in the workings on the deep; in all cases where inflammable gas exists, or may be expected in the future workings of the mine, a pit, on the rise of the strata, at which the gas may escape exclusively, would be a great advantage.

I have been induced to make the following observations from seeing a pamphlet, published by two professional gentlemen, respecting the explosion of fire-damp at the Aswell Colliery, in the North of England. These gentlemen recommend cast-iron pipes to be used to convey the gas from the old workings to a pit on the rise of the strata. That the inflammable gas which is produced in coal mines will ascend, or be the uppermost, has been long known to practical miners, because it is much lighter than atmospheric air; and as far as allowing it to escape in the natural way goes, it is perfectly right; but to put twelve-inch diameter cast-iron pipes into the old workings, for the purpose of conveying the gas from the goaves or hollows, would be very expensive indeed; and the plan appears altogether so absurd, that I am persuaded it will never be adopted, because the same object can be accomplished much more efficiently, and at a very trifling expense, compared with what it would cost by the mode which those gentlemen suggest.

A pit on the rise of the mine would not require to be more than seven or eight feet in diameter, as it would not be intended for a sale pit, except in particular cases, where it might be made available for selling coals; and where this was necessary, it might be made use of so long as doing so did not interfere with the object for which the pit was intended, beyond the selling of coals. But whether such a pit is available for this purpose or not, a certain quantity of coals will require to come out of it at the commencement, because the levels will have to be driven from it, to the boundary of the concern, or as far as may be considered necessary to drive according to circumstances, for the purpose of the work-

ings on the deep, to get through into these levels, and thus allow the gas produced in the workings below to pass up to the surface. All the workings on the deep of the highest rank of coal would terminate at these levels, and the gas would thus continually escape as it was produced in the old workings, until all the coals were brought to the shaft, or as near it as it would be safe to get them, so as not to injure it. A pillar of coal will be required on the deep of this shaft, sufficient in breadth to support it, and also for brows to be driven into it all the way on the deep, no matter how far it may be off, say at least for several hundred yards, as the workings below this shaft on the deep will terminate at these brows; and it must be so arranged, that the gas which is produced in the old workings shall escape into these brows, and thus ascend the shaft to the surface. The regular routine of working the mines below this shaft would go on as usual, and terminate at the brows on the deep. If the inclination of the mine be as gentle as it is in some parts of the north, the brows or roads in this pillar may be made available for bringing the coals which are worked on the deep to the shafts. If the mine is too steep to allow this to be done, then, if there be steepness enough, they would be available for jig brows, and so jig the coals to the shaft as the case may require. When all the coals have been obtained on both sides of the brows, the cut-throughs and cross-roads, which were made in the driving of the brows, must be left open for the gas to rise into them; and this should continue so until the whole body of coal on the deep is exhausted; in other words, till the concern is finished. If there be sufficient breadth of coal in this pillar, and the roof and floor of the mine are good and sound, the brows or roads in the pillar will last a long time, and the gas liberated will diminish, or perhaps become entirely exhausted in a series of years; at least what is produced in the old hollows, as they will fall in, and the floor of the mine will rise up, from the superincumbent pressure, where a large area of coal has been got, the old workings will consolidate, and thus the gas cease to flow.

The whole breadth of the pillar for these brows should be forty-five or fifty yards, which is considered sufficient to support the roof. If this breadth should be regarded insufficient to support the roof, fifteen or twenty yards additional may be left, as it is well to leave enough and be sure, because the whole, or at least the greater part, of the coal will ultimately be secured.

The stoppings in the cut-throughs, on each side of the centre brow, should be taken down as the different ranks are finished off; and the latter should be three fourths filled with rubbish in their whole length, as the rubbish will be a protection to the coal in the pillars, by preventing them bursting off at the foot; and there will also be plenty of room for the gas to escape, if they are filled in this manner. The gas which is produced from the fin-

ished workings on each side of the pillar, and which are part filled with rubbish, will pass into the centre brow, and to the pit on the rise.

At many collieries there may be difficulties in the way of carrying out this plan exactly as I have stated it. Such, for example, as in cases where large faults exist between the rise pit and the pits on the deep; there may also be other obstructions on the surface of various descriptions; but a practical man will readily see his way how to surmount them. An old pit on the rise of the workings, might be available for the purpose of allowing the gas to escape; and if it were not exactly where it might be considered in the best place, it is a matter of comparative indifference, if there be a saving of expense by using it, instead of sinking a pit for the purpose. The pit made use of for the escape of the gas, should be walled round three or four yards above the surface; it should also be closed at the top, and a sort of slide door fixed in it, so that the area for the escape of the gas may be enlarged or contracted, as circumstances might require. If there be not a door fixed at this pit, there may be too much air ascending it with the gas, which might interfere with the ventilation on the deep, and so far it would be objectionable.

Enough has been said on this subject, as I only wish to give the outlines; and if these suggestions are considered worth adoption, means may be taken to carry them out according to circumstances. It is necessary however to add, that what has been said, referring to allowing the gas to escape to the pit on the rise of the working from the deep, that this gas pit is considered to be sunk to the mine so worked, and also, as if there were solid coal to drive in at the same. Perhaps at all the old concerns, there would be no solid coal, as it would in all probability have been already got; but there are other means to be used if this be so. Where there are other mines above the one which is being worked on the deep, by using one of an inferior sort, in which a pair of levels might be driven to a certain distance from the shaft, and two or three small pits in different places sunk to the mine which is being worked below to the hollows, the gas would find its way through the broken strata into these levels, and in this way rise to the surface. If this inferior mine is too thin to be pursued, I would drive the levels wide enough to hold the dirt produced, so as to make height, rather than send it out of the pit; and if the coal were not found salable, perhaps it might be consumed on the premises.

If there be atmospheric air and this gas confined together, the gas will be uppermost; something like putting oil and water into a bottle. Agitate them as long as you will, they will not combine; put the bottle down in any position, and the oil will still be uppermost. It is similar with the inflammable gas of a coal mine and atmospheric air. They may be mingled by agitation;

but let them become quiescent, and the gas will resume its natural position. The water and the oil in the former case are visible, but the gas and atmospheric air are invisible. This illustration must be obvious to all.

These remarks are made as plain and simple as possible, in order that persons who may not be practically acquainted with the business may be able to comprehend the general idea.

In recommending a pit on the rise of the workings, at which the gas may escape from the workings below, or on the deep, it may be compared to the draining of a large portion of swampy land. A main drain is opened at the lowest point, to allow the water to run away as it is produced. Branches are also cut in various directions, connected with this main drain, so that the water may filter into them from the whole area of the bog or swamp. It is exactly the same with regard to having a pit on the rise of the mine, connected with the old workings, so as to allow the gas to flow away. It is as natural for this gas to ascend, as it is for water to find a common level. Balloons, which are only bags filled with gas (and a gas as inflammable as that which is produced in coal mines), are sure to rise in the air, the gas contained in the balloons being much lighter than atmospheric air, is the well-known cause of their ascension.

Some persons have recommended boreholes to be made from the surface upon the old hollows or goaves, so as to allow the inflammable gas to escape from the old workings to the surface. I think such a system would not be of any real use, for several reasons. For example: if the hollows or goaves were a great depth from the surface, and the water had been tubbed or stopped out of the pit in sinking, and the borehole passed through the strata in which the water was dammed up, to the hollows below, it would let the water which had been tubbed out fall down to the mine or hollows below, which would render the tubbing that had been effected in the pit of no avail, as the water would then have to be pumped from the bottom of the pit, and of course this would be a serious and expensive evil. But suppose there were no water, or but very little, it would still require a considerable sum to bore a hole two or three hundred yards deep; and if there were but a small quantity of water falling down the hole, it would have a great tendency to prevent the gas from rising up it; as water falling down a tube, will drive the air down with it; therefore, for these reasons, I should neither adopt it myself, nor advise others to adopt such a system. I have considered that a great advantage may be obtained by having wooden pipes fixed in the pit, all the way down from top to bottom, in cases of explosion, and other pipes to be connected with these in the pit from the shaft. The coal may be cut out on the deep side of the shaft level for these pipes, just sufficient to hold them; and thus be carried for some distance on one or both sides of the shaft. In

such a case, I am presuming, that the pipes have been so fixed and wedged up, that if there were an explosion, they would not be displaced, unless it was a very violent one indeed; and even in such a case, I am not sure whether they would not withstand the shock, because the pipes being fixed close to the side of the pit, they would not offer much resistance to the force of the blast. We shall now suppose that an explosion has taken place, and the pipes have not been injured. Some cast-iron pipes, three inches in diameter, must be connected with the wooden pipes at the top of the pit, and just sunk about a foot below the surface to be out of the way; and these pipes ought to go into the engine pond, a tap or valve being required at the end of them, so as to allow the water to pass from the pond into the wooden pipes fixed to the side of the pit. The pipes thus prepared and fixed, would be ready if an explosion took place. All that would be necessary, would be simply to open the valve at the pond, the water would then run down the three-inch pipes into the wooden ones fixed in the pit, and a stream of water the thickness of a man's wrist running down the wooden pipes would produce a water-blast at the bottom of the pit. Thus there would be a volume of fresh atmospheric air sent down the pipes in five minutes or less after an explosion; and the quantity of air descending the pipes would be such as no person could form any idea of, who had not seen a water-blast or its effects at the bottom of a coal-pit. If there were a few hundred yards of piping on each side of the shaft, connected with those in the shaft, fresh atmospheric air would also be sent to the extreme end of them in a few minutes after an explosion; and if the men who might not be killed by the blast could get to the end of those pipes, the after-damp could not hurt them before assistance could be rendered to them.

The wooden pipes at the top part of the pit must be open, so as to allow the air to rush down with the falling water; and to do this a little contrivance will be necessary at the bottom of the pipes, to prevent the force of the air from expending itself at the shaft. The water would overflow at the shaft, and the air would rush into the pipes, and in such quantity, that fully to believe, it must be seen. The wooden pipes may be nine inches by twelve, inside measure, as they would not take up much room. Of course every thing must be fixed and ready, both at the bottom and at the top of the pit. If both the up-cast and down-cast pits were thus prepared, I am inclined to think that this system would be much superior to having places of refuge in the bottom. There would be plenty of atmospheric air for the men at the end of the pipes, and also for those who were rendering assistance. If the air were foul in the road from the shaft to the end of the pipes in the bottom, so as to prevent those persons who were trying to render assistance from proceeding, I would then cut or bore a large hole in the pipes, say every ten or fifteen yards, as the men

went along. By so doing, as much air would pass into the road as would allow the men to proceed; and when they had gone as far as they could, let another hole be made in the pipes, and stop the hole behind with a piece of clay, thus advancing until the men were rescued. If the pipes were fixed as I have before suggested, I am inclined to think a very short time would be sufficient to have the men out of the pit after an explosion; and I have no doubt that those who escaped the flame and blast of the explosion would thus be saved. The interests of humanity, surely demand that this, or some more feasible plan, should be adopted without delay.

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ART. III.—NEW BRUNSWICK AND THE ACADIAN IRON MINES.*

DR. C. T. JACKSON gave a brief sketch of the Geology of New Brunswick and Nova Scotia, and described the silurian, carboniferous, and triassic rocks of those provinces; as also the metamorphic and trappean ranges of the Cobiquid and North Mountains. In these, his recent explorations, he was associated with John L. Hayes, Esq., of Washington, D. C., and was employed by Charles D. Archibald, Esq., of London. In describing the geology of New Brunswick, he began at St. John, and traced the rock formations from that place, following the line of travel up the Kenebekasis River to the Peticodiac. In the city of St. John, we find slates and metamorphic limestones, which, from the occurrence in them of a bed of hard sandstone containing a fossil tree, are regarded as belonging to the Devonian group. No mollusca, or indeed any fossils, are found in the limestone, which is made up of a mixture of the blue and gray varieties, highly metamorphosed by heat, and much disturbed in their stratification. Masses of sienite, consisting of flesh-colored feldspar and hornblende, without much quartz, are observed at Indiantown, and are rocks of igneous origin.

All along the Kenebekasis River, are observed red sandstones of the old red or Devonian group, and at Sussex Vale we come to the celebrated salt springs, which rise from the saliferous sandstones, and produce by evaporation, the finest and most agreeable table salt.

In Hillsboro' we find the lower members of the coal series, so remarkable for the abundance of fossil fishes of the genus Palæoniscus, and for that highly bituminous variety of coal, which has been called Albertite. This group of strata, with its fauna and flora, were formerly described before this Society. Hills of

* Proceedings of Boston Society of National History.

snow-white gypsum, and some extensive beds of anhydrite, occur in Hillsboro', and in other parts of Albert County. Naphtha springs also exist near the shores of the Peticodiac River, and petroleum floats on the surface of the waters that arise from them, and is deposited as a soft bitumen among the grass roots, and in the soil, it being left in its thickened and oxidized state by the water, as it periodically rises and falls with the seasons.

On reaching the mouth of Chepody Bay, we come to Mary's Point, and Grindstone Island, where beautiful buff-colored, and a light red sandstones of the carboniferous group, are quarried for building stones, and a blue variety of the same formation, which is used for making grindstones, is found. At this time the Mary's Point quarries present a scene of unwonted activity, owing to the enterprise of Mr. Archibald, who has employed upwards of seventy-five quarrymen, under the directions of Mr. George Lang, in quarrying out the freestone for architectural uses. These sandstones are found to be of excellent quality for building purposes, and are now being largely imported into the United States under the Ægis of the reciprocity treaty between the United States and Great Britain. Mr. Alger has, on a former occasion, demonstrated the durable nature of this sandstone, before this society, and our observations authorize us in confirming his opinion, that it withstands the action of frost even in the climate of St. John.

By far the largest amount of the stone is of a yellowish tint, or buff-colored, but there are also beds of light red, and gray-colored varieties. They are, however, of the same geological age, and belong to the true coal-bearing strata, as is proved by the fossil plants closely impacted between the beds of stone, and thin seams of bituminous coal, occasionally discovered in them.

An outlier of rock, called, from its singular shape, the "Squaw's Cap," presents us with an abundance of fossil trees, and roots, apparently of the Sigillaria, having none of the markings of Stigmaria, but with smooth and striated surfaces. Occasionally we find silicious nodules in the blue sandstone, which are called by the grindstone cutters "bulls-eyes." They injure the grindstones when they occur, and stones containing them are avoided.

Grindstone Island is one mile long, and half a mile wide, and is estimated to contain about 140 acres of quarry stone. The average height of the island above highest tides is sixty feet. The tide rises and falls between sixty and seventy feet. In obtaining slabs of the blue sandstone for making grindstones, these extraordinary tides perform valuable services, for the quarryman has only to split out the rock at low water, and fasten it by chains to his flat boat, and allow the rising tide to float it, so that he can transport the stone to high-water mark, and leave it where

he can work upon it at his leisure. It is observed that the best grindstones are always obtained from the strata which are submerged at every tide. They are softer, and less liable to have cracks in them, as they are not exposed to extremes of heat and cold. The strata all dip down under the Bay of Fundy, at an angle of 38 degrees to the southward, and the trend of the strata is nearly east and west.

Above the tides we have the extensive quarries now opened. They are supplied with heavy and massive cranes, and a tram road, or railway, for the removal of the stones and for transporting them to the wharf, where they are put on shipboard.

Owing to the favorable slope of the strata, beds of sandstone are here easily split up and removed, so that building stones are obtained at a very low cost.

On examining the "posts" of the quarry, we found that stones of from one foot to eight feet in thickness, and of any desired length and width, could be obtained, and that a supply of uniformly colored stones could be procured in abundance.

At present most of the stones sent from Mary's Point are sold in New York, Philadelphia, and Baltimore, no agency having been yet established in Boston.

## ACADIAN IRON MINES IN LONDONDERRY, N. S.

Travelling around the head of Cumberland Bay, we pass over the rich diked meadows originally reclaimed from the tidal overflowing by the first French settlers, and at length reach the Cobequid Mountains, which consist of sienite and greenstone, rocks of igneous origin, and highly metamorphic olive-colored slates, which immediately underlie the gray sandstones of the coal formation.

Mr. Dawson, in his Acadian geology, describes these slates as Devonian, which their stratigraphic position seems to indicate, but we find no fossils in the metamorphic rocks, to aid us in determining their precise equivalency. The line of their uplift is nearly east and west, and does not run parallel with that of the south mountains of Nova Scotia, which will presently be described as belonging to the N. E. S. W. system, and which are Silurian, and of the same age as the Niagara and Clinton groups of the New York system. On the southern slope of the Cobequid range, in these olive-colored slates, exist innumerable and extensive deposits of ochreous oxide of iron, amorphous and botryoidal hematite, specular iron ore, and a mixture of spathose iron ore and magnesian carbonate of lime, known under the name of *Ankerite*, which is also penetrated by abundant small veins, and investing masses of micaceous specular iron ore, which appears to have been introduced by plutonic sublimation. There is geological evidence of the igneous origin of the numerous

veins of Ankerite, and it is highly probable, as has been suggested by Mr. Dawson, that the immense deposits of yellow oxide of iron, have resulted from the decomposition of the carbonate of iron in the Ankerite. Volcanoes we know do give out abundant fumes of peroxide of iron, which crystallize as specular iron ore in the volcanic caverns. May not a subaqueous eruption have produced the pulverulent peroxide, abounding in these mines? Atmospheric causes do not appear to have been adequate to the decomposition of such enormous quantities of Ankerite, as would be required to yield so much of the peroxide. There are small veins, bunches and films of black oxide of manganese in these ores of iron, and this renders them more particularly valuable in the production of steel, since it has been discovered that an alloy of metallic manganese with iron is highly useful in the production of the finest steel, such as the iron from this ore is known to produce.

Since my return home, I have made chemical analyses of the ores of these mines, and have obtained the following results. Specimens of the Ankerite yielded on analysis:

| | *No 1 Yellow Ore.* | *No. 2 Brown Ore.* |
|---|---|---|
| Carbonate of iron, | 23.45 | 20.80 |
| Carbonate of manganese, | 0 80 | |
| Carbonate of lime, | 43.80 | 49.20 |
| Carbonate of magnesia, | 30.80 | 30.20 |
| Silex, | 0.10 | |
| | 99.95 | 99.70 |

This ore contains in No. 1, 16 42-100, and in No. 2, 16 1-10 per cent. of pure metallic iron. The limestone or carbonate of lime in it serves perfectly for a flux in smelting the ore in the blast furnace.

An average sample made up from all the ores of the mines mixed, yielded in 100 grains:

| | |
|---|---|
| Peroxide of iron, | 74.80 |
| Oxide of manganese, | 2.20 |
| Silica, | 2.20 |
| Titaniferous Iron, | 1.80 |
| Calcareous matters, | 19. 00 diff. |

This ore contains 52 38-100 per cent. of pure metallic iron, and if the manganese is all reduced and alloyed with the iron, it will amount to 1 53-100 of manganesium; the proportion which will make the iron into the finest kind of steel.

There is one blast furnace now in operation at the Acadian mines, smelting these ores, and six Catelan forges are also employed. The iron produced is remarkable for toughness and strength, and is sold exclusively to steel-makers in Sheffield, Eng. Since the immediate country around is hard-wood forest

land, an abundance of charcoal fuel can be obtained, and there will soon be other furnaces built near the mines.

Having completed our survey of the numerous mines near the Acadian furnaces, we left for Truro and Halifax by stage coach, and from thence went to Windsor, where we crossed over the gypseous formation, and observed some of those numerous inverted funnel-shaped cavities in the gypsum, which now and then operate as trapfalls for men and animals.

Reaching the valley of Annapolis River, we travelled down it to Nictau, where we made a full examination of those inexhaustible beds of iron ores, which are worked by Mr. Archibald, and have been named by him the

VICTORIA MINES.

In 1827, Mr. Francis Alger, and myself, made the first geological examinations of these curious and most interesting ore beds, which are contained in argillaceous slate rocks of silurian age, having a line of elevation running N. E. and S. W., and are distinguished by the great profusion of fossil shells which they contain, the ore being more fossiliferous by far than the slate rocks containing it, seeming to indicate that these ancient Mollusca had a preference for an iron bed rather than one of clay. Formerly the principal fossil shells of these ores were regarded as a species of terebratulæ, and afterwards they were classed as Delthyris, but now they are arranged under the genus Spirifer, and they approach closely the S. Niagarensis, though none of them agree exactly with Mr. Hall's figures of that species. In 1827 I discovered a trilobite in one of these iron ore beds. It was called Asaphus crypturus by Prof. Green, of Philadelphia, who described it for me at the time. Tentaculites also occur in the red iron ore of Little River, one of the beds of this group. The species resembles in form and size the magnified drawings of T. Minutus of Hall's Clinton group of New York fossils. There are Orthocera and several others, as yet unknown or undescribed Mollusca, in these ores, and it is difficult to determine their species, since we have only the interior moulds of the shells. They all appear to belong to the Niagara and Clinton groups of the New York system. One of the most curious phenomena presented at these mines is the magnetic state of some of the ores, while others not far removed from them are wholly devoid of magnetism.

The ore, when deposited at the bottom of the sea, must have been a fine ferruginous mud of peroxide of iron. Since its formation, and probably at the time of its elevation, the most metamorphosed beds were rendered magnetic iron ore, a mixture of the protoxide and peroxide.

A great number of mines have been opened lately on these ores, and some new beds have been discovered since the original survey was made by Mr. Alger and myself. There are two

15 C

principal and parallel beds, which vary in thickness from 6 to 10 feet, and they have been traced with certainty five miles in length, and probably extending to Bear River, near Clements, are thirty or more miles in extent! Whether these two parallel beds, which are near each other, and dip 80 degrees, constitute one bed doubled up like the letter U, or are distinct deposits, we were, in the short time allowed us for our examinations, unable to decide. There are, however, several distinct and separate beds beside the main ones,—some of them are very compact and magnetic, and others are softer, and are not magnetic ore. The last-named variety is seen in the red slates in Little River, and the others near Nictau River, and in very numerous pits, and trenches, cut for the purpose of tracing the beds.

It was found impossible to rely upon the compass needle in surveying the magnetic ore beds, for the needle was astatic over them, and was attracted, even when quite remote from the ore—the North point invariably pointing towards the iron ore. It is quite evident that these mines may be considered, most truly, to be inexhaustible, and the wood of the country around, though it may supply fuel for many years, is not adequate to smelt more than a very small proportion of the ore actually in view. Hence it is advisable to export much of the ore to the United States, as well as to make charcoal iron for steel on the spot, for exportation to England.

This we have advised, and have no doubt of its being done, under the new laws of reciprocity in trade with the British colonies, which will allow of the introduction of iron ore into this country, and of the exportation of anthracite to Nova Scotia, free of duty; but the iron made in Nova Scotia cannot be brought to the United States without paying duties, and hence it will be sent to England. This will be mostly fine charcoal iron for making steel.

Anthracite will smelt the Nictau ores with great ease and with but little additional flux, since there is in it silex, and nearly enough lime to make a fusible slag. The anthracite iron made from this ore will be very strong and good, but not so valuable, of course, as charcoal iron. It will make good foundry pig and and good bar iron.

*Chemical Analysis of the Nictau Iron Ore.*

This ore dried at 212 degrees yielded in 100 grains:

| | |
|---|---|
| Peroxide of Iron, | 70.20 |
| Silica, | 14.40 |
| Carbonate of lime, | 5.60 |
| Carbonate of magnesia, | 2.80 |
| Alumina, | 6-80 |
| Oxide of Manganese, | 0.40 |
| | 100.20 |
| Gain of Oxygen, | 0.20 |
| | 100.000 |

It contains 50 42-100 per cent of pure iron.

The results of smelting of the ores and of refining the iron prove that either white forge, or gray foundry pig iron can be made from them by management of the burden of the furnace, and that the refined or bar iron is nearly, if not quite, equal in toughness to that from Russia and Sweden. It also makes fine cast steel, as has been proved by trials made of it in Sheffield, England.

John L. Hayes, Esq., of Washington, corresponding member, confirmed Dr. Jackson's statements with regard to the Nova Scotia iron. He remarked also that American iron, manufactured by means of charcoal, was the only iron used in the chain cables of the United States Navy, which are all manufactured at the Navy Yard, in Washington. He related instances, where cables of the best English iron had been broken in storms, when those of American charcoal iron had held. He thought that the value of charcoal iron over anthracite iron was underrated, especially in places where wood could be obtained and readily transported for making charcoal. English manufacturers are now turning their attention to this country, since the supply of Russian iron has failed, and as the supply from Sweden may be cut off by political causes; and he believed that preference would be given, at some future time, to charcoal iron from the Acadian mines, from which steel of the highest quality can be made. It is well known that some irons make better steel than others, and on this account have been said to have a *steely propensity.* The cause of this is not yet understood, but as manganese is found in all the steely irons, it is very probable that future investigations will establish the fact of manganese beeng the cause of the steely propensity.

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## Art. IV.—WESTERN RAILROAD IRON WORKS.

The rapid increase in extent of the railroads of this country, and the large amount of iron necessary for their construction and annual maintenance, has for some years enlisted the attention of sagacious and far-seeing men. The most recent and careful estimates on the progress of our railroads present these results:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| At the close of | | | | 1847, | in running order, | | 3,000 | miles. |
| " | " | " | " | 1852, | " | " | 12,800 | " |
| " | " | " | " | 1854, | " | " | 19,500 | " |
| " | " | " | " | 1855, | about | . | 22,000 | " |

In this estimate a road with a double track is doubtless reckoned of double length. It shows that from

| | | |
|---|---|---|
| 1847 to 1852, inclusive, five years, the increase was | 9,000 | miles. |
| Average construction per year, . . . . | 1,800 | " |
| From 1853 to 1854, two years, . . . . | 6,700 | " |
| Average per year, . . . . . | 3,350 | " |
| In 1855, about . . . . . | 2,500 | " |
| From 1847 to 1855 inclusive, eight years, . . | 18,200 | " |
| Average per annum, . . . . . | 2,275 | " |

Where will be the limit to the progress of our railroads it is useless to estimate. As a means of transportation, they must extend, with the increase of population both in the old and in the new States, until they become like a mesh of the veins of the body.

The amount of iron required to the mile, under the heavier rail now introduced, is generally estimated at about 100 tons. The following estimate will present some idea of the average annual demand of iron for these purposes, as based on the experience of some years past. Taking the average annual increase of railroads at only 2,000 miles, which is under the reality, it shows these results:—

| | | |
|---|---|---|
| 2,000 miles of new roads, . . . . . | 200,000 | tons. |
| 10 per cent. on the amount of iron now down, (which is about 2,000,000 tons) for repairs, switches, tracks, &c., . . . . . | 200,000 | " |
| Iron used for other purposes, say locomotives, spikes, shops, &c.. which is estimated at 90 tons per mile, . . . . . | 180,000 | " |
| Total, . . . . . | 580,000 | " |

If the average annual progress of railroads had been put at 2,500 miles, which is much less than the actual increase for 1853 and 1854, this estimate would have reached 675,000 tons. In the year 1853 the amount of bar iron imported was 405,000 tons, of which four fifths were for railroads. At the same time several large iron works in this country were engaged in the manufacture of bar-iron.

Here, then, is a certain and positive annual demand for iron for railroad purposes of not less than 580,000 tons. It would be just in this estimate to take into consideration an average annual increase, but time will show how much this should be. To have a fair view of the permanency and steadiness of this demand, some consideration should be given to the manufacture and consumption of iron for all general purposes.

The census of 1850, which is much in arrears of the present time, and the Report of the Treasury Department, furnish the following facts:—

| | |
|---|---|
| Pig iron made in the United States in 1850, about | 600,000 tons. |
| Manufactured iron imported, | 47,000 " |
| Pig iron imported, | 114,287 " |
| Bar iron imported, | 405,000 " |
| Steel, &c., &c., | 12,937 " |
| Aggregate iron consumed, | 1,179,174 tons. |

Professor Wilson, one of the English Commissioners sent here in 1853, and who extensively investigated the subject, furnishes the following estimate of the iron business of our country:—

| | |
|---|---|
| Consumption, | 1,200,000 tons. |
| Production, | 800,000 " |
| Wastage, | 100,000 " |
| To be imported, | 500,000 " |

The consumption at the present time is doubtless far in advance of this estimate. The facts subsequently developed relative to railroads, show the annual demand in that quarter to be greater than this estimate of the entire amount to be imported.

Let it be supposed that the annual growth of the United States is three per cent., and the annual construction of railroads at 2,000 miles, the double tracks and repairs at about the same, and the iron used as above estimated; and the production, consumption and demand of iron five years hence will be nearly as follows:—

| | |
|---|---|
| Consumption in the United States, | 1,725,000 tons. |
| Produced in do., at present rate of increase, | 1,060,000 " |
| Demand over present ratio of production, | 665,000 " |
| Railroad iron required, | 650,000 " |

These results are based upon undeniable facts, and they show a large demand for iron in this country for some years, which can be met only by a rapid increase in the manufacture or by importation. To make our own iron, and, for that purpose, to increase our own iron works, should be a primary object of consideration. In this connection, however, there is another question of importance to capitalists and mine owners, which is, to what extent iron can be made in this country to compete with the imported iron made by the cheap labor and cheap capital of Europe.* West of the Alleghanies the iron manufacturer possesses an advantage not enjoyed by his fellow-laborers on the

* This point will be examined in a future number of this Magazine, in an article upon the Tariff, or Rates of Duty on Iron, a subject which is already attracting attention at Washington, and which is too frequently regulated according to political rather than *economical* considerations.

Atlantic coast. Foreign iron cannot reach the Western market without an additional and heavy freight, about ten dollars per ton, which is so much in favor of the Western manufacturer.

We have been led into an investigation of these facts from an examination of the Report of Dr. D. D. Owen, of Indiana, upon the property of the *Saline Coal and Manufacturing Company*, located in Southern Illinois, and from a desire to treat their vast enterprise with that justice and consideration to which, from its unusual merits and importance, it is entitled. For this purpose we shall consider three points,—

1st. What objects this Company aims to accomplish.

2d. Their facilities for accomplishing them.

3d. The means by which they propose to do it.

This examination will involve many interesting particulars relative to the production of coal and the manufacture of iron in the Western States, which we shall endeavor to treat as fully as our limits will permit.

The Saline Coal and Manufacturing Company was organized under a charter from the State of Illinois in 1851, and commenced the manufacture of iron and the improvement of their property. Its interests, its stockholders, and its future business, is and will be west of the Alleghanies. The manufacture of railroad iron, to an extent in some degree proportionate to the vast and increasing demand by the railroads of the West, is the ultimate aim of their enterprise; which perhaps may be most suitably expressed in their own words:—

The scope and general objects of the Company is not mainly nor chiefly the production of coal, as its name, and, indeed, its incipient operations, would imply, but the establishment in the West of *Railroad Iron Works*, on a scale larger than any other one concern of the kind in the world, and to endow it with sufficient capital to enable it to compete, in point of terms, for the sale of its products with any in Great Britain. A careful examination of the facts will not fail, we think, to convince you that this Company can produce railroad bars at a cost of not exceeding $30 per ton. The freights, duties and commissions upon the English rails (which, under all circumstances, has to be paid in cash) does not usually fall much below this sum, and sometimes exceeds it. It will be the policy of this Company to exact a cash payment upon iron equal to the freights, duties and commissions on foreign iron at the time of sale; and as this will nearly or quite cover the cost of production, it is easy to see that it will be in the power of this Company to grant such credits to responsible Companies as the circumstances of their case may require, to an extent equal to the cost of rails in Great Britain. It is estimated that it will hereafter require one hundred thousand tons of rails *annually* to repair the roads now already in use west of the Mountains. The freights, duties and commissions upon this quantity of iron, which *must be had*, will amount to more than $2,500,000 every year.

In case of war between the United States and Great Britain, what would be the position of the railroads of this country, and especially those of the West?

With a make of railroad iron in the United States not exceeding 60,000 tons per annum, the greater portion of which is produced in mills designed for rolling merchant bar, and which, in case of the stoppage of importations

of this class of iron would fall back upon the manufacture of that article from the imperative necessity of having it, and the high price it would bear, so that the quantity of railroad iron produced would not exceed 30,000 tons per annum.

But the railroads east and west of the Mountains require annually for repairs 200,000 tons, and there would be a deficiency of 170,000 tons per annum to make these repairs.

What would the interest in railroads be worth if this most vital of all their necessities could not be supplied? Not much, with a dilapidated track leading to damages, not only of rolling stock, but of every kind and description of life and property.

Having acquired all the real and mineral estate necessary to give permanency to the mining and manufacturing interests contemplated, as well as the most eligible site for a commercial and manufacturing town, on the banks of the Ohio River, and having made such improvements as were necessary to bring the coal and iron to the producing point, the time has arrived when we can with confidence and propriety present our plans to the public, and invite capitalists to put their money with ours, for the further development of this estate.

We have begun this enterprise with no speculative views; but for the profitable employment of our own capital, and, to a certain extent, the capital of those who may choose to join us at this stage of our progress. We know that, even with the limited amount of improvement which our means have enabled us to make, the products will sustain the Company, and give a reasonable dividend to its shareholders.

But the amount of improvements is so disproportioned to the mineral resources of the property, that we would gladly accept further tenders to the amount of a million, or, at most, a million two hundred thousand dollars.

This addition to our capital would enable us greatly to extend our coal product; would build four blast furnaces and one rolling mill; would develope our salt to a production of five hundred bushels per day, and give us an ample money capital for the conduct of the business of the Company.

In other words, this Company, with inexhaustible treasures of coal, iron, limestone, &c., and an immense and permanent demand for railroad iron pressing upon them, design to extend their capital to an amount about equal to that of the Pennsylvania Coal Company, or the Delaware and Hudson Canal Company, whose stocks are among the most substantial securities in our markets, and commence the manufacture of iron on a scale commensurate with the demand.

The next point to be considered, embraces the facilities which this Company possess for the achievement of such a great enterprise. Its consideration will lead us into a somewhat extended examination of their resources.

Their property is located in the southern part of the State of Illinois, in Hardin County, on the Ohio River, about one hundred miles from its mouth. It extends two miles on the Ohio and eighteen miles on the Saline River, at its junction with the Ohio. This embraces all the seams of the lower coal measures of the central bituminous coal field of the Mississippi Valley, including also the seams of carbonate of iron pertaining to this coal formation.

It is an important fact, that a line drawn transversely through

the property of the Company, would cut the outcrop of all these coal and iron seams within a space of two miles, giving access to the entire series, above high water, and is the key to the southern outcrop of this great coal formation.

The whole frontage on the Ohio River is a bold and good landing, at all stages of the water.

The Saline at high water is navigable to Equality, about seventeen miles from its mouth, and at the lowest stages is navigable about three miles, to a point where the railroad of the Company terminates, and where the saw-mills, machine and workshops, and boat-yard are located. To this point it is about 300 feet wide, and as deep as the channel of the Ohio—which backs its water thus far—providing a basin of still water, three miles long by 300 feet wide, in which all kinds of craft may lay. When the commerce and traffic of the Company shall have become as large as is contemplated, this basin will be invaluable to them, forming, as it does, a perfect harbor from the currents, ice and drift of the Ohio.

The Little Saline enters the Big Saline about one mile and a half above the mouth of the latter, and has its source in a depression of the ridge dividing the head waters of Big Creek from those of the Little Saline. This sandstone ridge being the division between the coal formation and the carboniferous limestone which bears the brown hydrated oxide of iron, or hematitic ore, which occurs on the estate of the Company, immediately adjoining this ridge. The valleys of the streams and the depression of the ridge afford easy grades for a railroad, to connect the hematitic iron ore with the coal field. The Company have here more than 4,000 acres of this class of property, in which the ore occurs in large surface deposits, the overflow of crevices which traverse the limestone in determinate lines of fracture.

On this estate there are three of these parallel fissures—one twenty-four, and one twenty-seven feet in width. The width of the other has not been determined—one of its walls only having been discovered. These are crossed at right angles by another fissure, twelve feet wide.

On this property the company have one charcoal furnace, in blast, producing from eighteen hundred to two thousand tons per annum of very superior pig iron, for forge or foundry purposes, and all the necessary shops, mills, machinery, tools, stock and dwellings, for the use of the furnace and its employées, with about three hundred acres of land under cultivation, with the requisite farm houses, barns, etc.

The coal estate commences on the Saline adjoining the city plot, two miles above its mouth, and extends up along the course of that river, over eight miles, including for the most part, both of its shores, and embracing an area of about six thousand acres. The coal measures on this estate have a vertical thickness of 850

feet, in which occur no less than thirteen seams of coal, seven of which are considered workable, being from three feet to five feet six inches thick, in all, an aggregate thickness of thirty-two feet. Several of the other seams are two feet six inches thick, which are not considered workable, so long as the thicker ones are accessible.

Interstratified with the coal, are no less than six seams of carbonate of iron occurring in the shales. It is stated, that in every square mile there is enough to produce (if all taken out) over five millions of tons of iron, or 7,812 tons per acre.

The intervening spaces are filled with sandstone of various qualities, suitable for building purposes, firestone for furnaces, grindstones, slate, fire clay, etc. In an outcrop of so great a thickness occurring within a space of two miles, the facility of working such parts as may be required is an important consideration.

Upon this property, three coal pits are opened, with railroads extending from them to the river, all in complete working order.

The real estate does not lay in one entire connected mass. The reason is, that selections have been made, because of some known advantage which each specific location possessed—one at the mouth of the Saline, a site for a manufacturing and commercial city, of about 2,400 acres; another for its coal and its iron ore; and others again for their marble, their porcelain clay, their cypress timber, their white oak, etc.

It appears that the acquisitions to the estate have been made, and the prosecution of the improvements carried forward by a few individuals with the greatest care, and on the most complete and reliable data.

They regarded this region as the most central in the United States, with reference to consumption, where coal and iron could be found in close proximity, upon navigable waters, and seem determined from the commencement successfully to achieve a result in the production of coal and iron, which should be not only creditable to American enterprise, but highly remunerative to the capital invested, hence a large tract of mineral property had to be purchased from various parties.

But in order to obtain a more precise estimate of the intrinsic value of these mineral deposits, let us accompany Dr. Owen through some of the more important steps in his examination of them.

Mr. Owen proceeds as follows:—

I shall first describe the coal district lying on the Saline, and between that stream and the Ohio River, from the Chamberlain mines to the confluence of the above streams, thence to the mouth of Little Cane Creek.

The formation prevalent over the greater part of these lands, most of which are owned by the Saline Coal and Manufacturing Company, is referable to the lower coal measures of the middle Coal Field of the Mississippi Valley; bounded on the north by the tilted strata of Gold Hill and the mill-stone grit range, forming the northern limits of the Kirkendale Valley, and running towards the Island Riffle of the Saline; on the west by the Shawneetown disturbance; on the east by the Ohio River; and on the south by the conglomerate and mill-stone grit, bearing from Battery Rock, in a north-westerly course, towards the mouth of Little Cane and Little Saline Creeks by Dutton Cliff; thence westerly, with some interruptions, near the north line of sections 10 and 11, T. 11, R. 9; thence towards section 6 of same T. and R., until it meets the dotted line, marked on the map accompanying this report, which defines the general boundaries between the mill-stone grit and the lower coal measures, existing in the Brinkley and Hubb's settlements on Eagle Creek, which lies chiefly in Sections 15, 16, and 17, T. 10, R. 8.

The lower coal measures of the Saline have a vertical thickness of about 850 feet, extending from the conglomerate of Dutton Cliff, to a sandstone, which forms a conspicuous member, capping the hills above the Chamberlain mine, and generally known throughout this country, by the name of the "*Anvil Rock.*"

In a vertical height of 112 feet, extending from the base of the *Anvil Rock* to within twenty feet of high-water mark, there are embraced three workable beds of coal. Their thickness and relative distance apart will be seen by the following section:

| | ft. | in. |
|---|---|---|
| 1st. Coal under the Anvil Rock, or Chamberlain Coal, | 3. | 9 |
| Space, | 45. | |
| 2d. Coal under the Anvil Rock, or Middle Bed, | 3. | 2 |
| Space, | 54. | 7 |
| 3d. Coal under the Anvil Rock, main Saline, or Woodward Coal, | 5. | 2 |
| | 111. | 8 |

From the five feet, or main coal, down to the bed of the Saline, below the fish dam, in Section 34, T. 10, R. 9., about one mile south of the Woodward opening into the five feet bed, the vertical height is 223 feet.

This space includes two more workable beds, and a third, which is probably 2 1-2 feet thick; besides two other thin beds. The thickness and distance apart, of these coals, is given below.

MAIN OR FIVE FEET COAL.

| | ft. in. |
|---|---|
| Space, | 98. |
| Coal struck in well, below the Woodward opening, | 2.6 |
| Space, | 89.8 |
| Coal, | .4 |
| Space, | 54. |
| Coal, | 8. |
| Space, | 32. |
| Coal, | 4. |
| | 223.6 |

There is said to be, still another thin seam of coal in these measures, between the 5 feet coal, and the coal struck in the bottom of the well, about 50 or 60 feet below the main coal. This is on the authority of the man who dug the well, who communicated the fact to Mr. Samuel Casey.

The last or four feet coal, crops out in the bed of the Saline, on its east bank, below the Fish dam, 9 1-2 feet above low water, on Raleigh Bar of the Ohio. Thus in a vertical height of 335 feet, and a horizontal distance of 1,830 feet, these two sections on the Saline have been obtained, in which no less then five workable beds of coal, crop out between the base of the Anvil Rock and low water. The united thickness of these five beds of coal is from 19 to 20 feet, and this does not include the 2 1-2 feet coal, in the bottom of the well, nor any of the thin interstratified seams.

For the quality of these coals, I refer you to the following cheminal analysis, made since I returned from the Saline mines to my laboratory.

First analysis of 1st coal under the Anvil Rock—Chamberlin mine.

SPECIFIC GRAVITY, 1.273.

| | | |
|---|---|---|
| Total volatile matter, | 34.55 | |
| Coke, | 65.45 | |
| | | 100.00 |

Swells up in coking, not disposed to coke in burning.

| | | |
|---|---|---|
| Moisture, | 2.00 | |
| Volatile gases and bituminous matter, | 32.55 | |
| Fixed carbon in coke, | 54.45 | |
| Ashes (white), | 11.00 | |
| | | 100.00 |

Second analysis, same coal, from a different block, taken lower in the bed.

| | | |
|---|---|---|
| Total volatile matter, | 40.30 | |
| Coke, | 59.70 | |
| | | 100.00 |
| Moisture, | 1.5 | |
| Volatile gases and bituminous matter, | 38.8 | |
| Fixed carbon in coke, | 55.2 | |
| Ashes (light grey), | 4.5 | |
| | | 100.0 |

First analysis of middle or second coal under Anvil Rock.

SPECIFIC GRAVITY, 1.476.

| | | |
|---|---|---|
| Total volatile matter, | 36.6 | |
| Coke, | 63.4 | |
| | | 100.0 |

Swells up still more than the preceding in coking, and forms a cellular coke, coheres slightly in burning.

| | | |
|---|---|---|
| Moisture, | 3.0 | |
| Volatile gases and bituminous matter, | 33.6 | |
| Fixed carbon in coke, | 54.4 | |
| Ashes (grey), | 9.0 | |
| | | 100.0 |

Second analysis of same coal.

| | | |
|---|---|---|
| Total volatile matter, | 37.3 | |
| Coke, | 62.7 | |
| | | 100.0 |
| Moisture, | 2.0 | |
| Volatile gases and bituminous matter, | 35.3 | |
| Fixed carbon in coke, | 54.7 | |
| Ashes (grey), | 8.0 | |
| | | 100.0 |

First analysis of main, or five feet coal—Woodward Mine.

SPECIFIC GRAVITY, 1.285.

| | | |
|---|---|---|
| Total volatile matter, | 38.0 | |
| Coke, | 62.0 | |
| | | 100.0 |

Does not swell up in coking, as much as the two preceding, adheres slightly in burning.

| | | |
|---|---|---|
| Moisture, | 2.0 | |
| Volatile gases and bituminous matter, | 36.0 | |
| Fixed carbon in coke, | 59.5 | |
| Ashes (grey), | 2.5 | |
| | | 100.0 |

Second analysis of same coal.

| | | |
|---|---|---|
| Total volatile matter, | 38.3 | |
| Coke, | 61.7 | |
| | | 100.0 |
| Moisture, | 1.0 | |
| Volatile gases and bituminous matter, | 37.3 | |
| Fixed carbon in coke, | 56.7 | |
| Ashes (steel grey), | 5.0 | |
| | | 100.0 |

Assuming the data arrived at by Johnston, Hayes and Rogers, from experiments performed by them on coals of nearly the same chemical composition, as your main five feet coal, the practical properties of that coal may be thus expressed. The weight of a solid cubic foot will come within a fraction of 80 pounds; but broken in lumps, only about 48 pounds. To stow a ton, it will require about 46 cubic feet of space, when burning about eight pounds of coal per hour, on a square foot of grate; it will require about 45 to 50 minutes, to bring a boiler into full and steady action, while the semi-bituminous coals require nearly an hour and a half, and the semi-anthracites two hours and half, and *the anthracites* over three hours, to accomplish the same effect.

It will evaporate thirteen and three quarter cubic feet of water, per hour. For every pound of coal consumed, it will produce eight and a half pounds of steam at 212°; one cubic foot of coal will furnish about 440 to 450 pounds of steam.

For completeness of combustion, it takes a rank above the average, there being only about 7 to 8 per cent. of waste, in the form of ashes, cinder, and coke. It will reduce from 27 to 28 parts of litharge, while the Beaver Meadow anthracite reduces from 32 to 33 per cent.; the semi-anthracites about the same, and the semi-bituminous about 30 per cent.

For rapidity of ignition it takes a high rank, being six times greater than that of anthracites; and about twice that of semi-bituminous coals. For evaporative power, under equal bulks and weights, it takes an intermediate rank. Sixty pounds of this coal will produce from 13 to 14 links of chain cable, of 1 3-8 inches diameter.

First analysis of three feet coal, or Little vein.

SPECIFIC GRAVITY, 1.309.

| | |
|---|---|
| Total volatile matter, | 35.6 |
| Coke, | 64.4 |
| | 100.0 |

Swells up in coking, adheres slightly in burning.

| | |
|---|---|
| Moisture, | 2.0 |
| Volatile gases and bituminous matter, | 33.6 |
| Fixed carbon in coke, | 60.4 |
| Ashes (white, or light grey), | 4.00 |
| | 100.0 |

Second analysis, same coal.

| | |
|---|---|
| Total volatile matter, | 38.3 |
| Coke, | 61.7 |
| | 100.0 |
| Moisture, | 3.0 |
| Volatile gases and bituminous matter, | 33.65 |
| Fixed carbon in coke, | 59.85 |
| Ashes (reddish grey), | 3.50 |
| | 100.0 |

First analysis of four feet coal, bed of Saline Creek, below the Fish Dam.

SPECIFIC GRAVITY, 1.274.

| | |
|---|---|
| Total volatile matter, | 34.9 |
| Coke,* | 65.1 |
| | 100.0 |

Puffs up more in coking than the preceding, does not coke in burning.

| | |
|---|---|
| Moisture, | 1.5 |
| Volatile matter and bituminous matter, &c., | 33.4 |
| Fixed carbon in coke, | 59.1 |
| Ashes (grey), | 6.0 |
| | 100.0 |

* When the coke is prepared in an iron crucible at a slow heat, from two ounces of this coal, it gives 72.98 per cent.

Second analysis of same.

| | |
|---|---|
| Total volatile matter, | 34.9 |
| Coke, | 65.1 |
| | 100.0 |
| Moisture, | 1.5 |
| Volatile gases and bituminous matter, &c., | 33.4 |
| Fixed carbon in coke, | 53.6 |
| Ashes (dark reddish brown and slightly magnetic), | 11.5 |
| | 100.0 |

Third analysis of same.

| | |
|---|---|
| Total volatile matter, | 37.7 |
| Coke, | 62.3 |
| | 100.0 |
| Moisture, | 2.0 |
| Volatile gases and bituminous matter, &c., | 35.7 |
| Fixed carbon in coke, | 59.3 |
| Ashes (dark ash color and strongly magnetic), | 3.0 |
| | 100.0 |

The amount of fixed carbon will be increased more than 10 per cent. when this coal is coked in bulk on a large scale; for I find that on operating on one pound of the five feet bed, coking in an iron crucible, with a weighted luted cover, leaving only a very small aperture for the escape of the gases, the coke weighed 69.60. The degree of pressure under which coal is coked, not only increases the amount of fixed carbon, but influences materially the density of the resulting coke; as will be seen from the following experiments on the five feet coal.

When one pound of the coal is used, and the gas confined as much as possible, the specific gravity of the resulting coke is 0.9880; when but two ounces of coal is employed, and gas allowed to escape freely, the specific gravity of the coke is but 0.582; and that of the three feet bed, from the same quantity (two ounces) of the coal, 0.625.

The inference, to be deduced from these experiments, fully demonstrates, that the quantity and texture of coke made from coals, disposed to form cokes of too cellular and honey-comb structure, can be greatly improved by coking under considerable pressure; while, at the same time, the amount of fixed carbon is increased.

These coals belong to the dry and not very adhesive varieties of fat, or soft free burning bituminous coals, such as occur in the coal basins of Scotland and Yorkshire.

The analysis given below, of the "*Clyde Splint coal*" of Scotland and the Worsboro furnace coal of Yorkshire made by Mushet, corresponds very closely with the analysis of the Three and Five feet beds.

Analysis of "Clyde Splint coal," by Mushet.

| | |
|---|---|
| Volatile matter, | 36.80 |
| Carbon, | 59.00 |
| Ashes, | 4.20 |
| | 100.0 |

Worsboro Furnace coal.

| | | |
|---|---|---|
| Volatile matter, | . . . . . | 88.18 |
| Carbon, | . . . . . | 60.32 |
| Ashes, | . . . . . | 1.50 |
| | | 100.0 |

The Youghiogheny coal of Pennsylvania indicates only from one to six tenths of one per cent. more fixed carbon, than the three feet bed, and from six tenths to three and one half per cent, more fixed carbon, than is found in the five feet bed of the Saline.

For comparison, I here subjoin my analysis of Youghiogheny coal.

| | | |
|---|---|---|
| Total volatile matter, | . . . . . | 36.46 |
| Coke, | . . . . . | 63.54 |
| | | 100.0 |
| Moisture, | . . . . . | 1.11 |
| Volatile gases and bituminous matter, &c., | . . . | 35.35 |
| Fixed carbon in coke, | . . . . . | 60.14 |
| Ashes (dark grey), | . . . . . | 3.40 |
| | | 100.0 |

The three feet coal of the Saline, contains in fact, a larger proportion of fixed carbon in the coke, than I have found in any coals, adjacent to the Ohio River, west of Pittsburgh.

This is a very important consideration, in estimating the value of your coal, for manufacturing purposes, for it is now a well ascertained fact, that the heating power of coal, is mainly due to the fixed carbon in the coke, and that the volatile matter contributes but little in this respect; indeed, the experiments of Augustus A. Hayes, M. D., and Professor H. D. Rogers, on Pennsylvania coals, go to prove that, "in the ordinary way of practice with the boiler furnaces now in use, the absolute equivalent of heat belonging to the coke (all of which is not procurable, however), exceeds considerably, with rare exceptions, that which is actually produced by experiment on the original coal." And numerous elaborate researches by other experimenters show, that, with very many samples of bituminous coals, the heating effect of the whole volatile portion of the fuel is almost "absolutely negative;" and this opinion seems to be gaining ground. This is probably mainly caused by the absorption of heat, by the aerial principles and moisture being suddenly converted from the solid and liquid, to the gaseous state.

A certain portion of easily combustible volatile gases are necessary and useful, in kindling readily the solid carbon, but beyond what is required for this purpose, it is doubtful whether the volatile gases are of any utility whatever, in the normal generation of heat, as furnaces are at present constructed. You will perceive also, that the ashes are small in quantity, rather light in color, and I believe, so far as I have observed, not disposed to

form clinker; but I have not had time to test the ashes for alkalies, on which this property mainly depends.

For rapidity of ignition, the coals of the Saline take a rank considerably above the mean.

For evaporative power, under equal weights, they will rank along with the Liverpool, New Castle, Scotch and Yorkshire coals; and the three feet and five feet beds, and perhaps the four feet bed, seem to be equally well adapted for furnace operations and manufacturing purposes generally, as far as can be judged, by a comparison of their respective chemical constituents.

The three upper beds of coal underlie the lands of the Saline Coal and Manufacturing Co., situated on sections 7, 18, 20, 21, 22, 23, 26 and 27, T. 10, R. 9, comprising an area of 2,840 acres.

It is probable that the five feet bed may be found also on sections 17 and 20, T. 10, R. 9.

Putting the united thickness of the three upper beds, under the Anvil Rock, at eleven feet, and the number of acres over which these beds extend on your land, at 2,840, and the weight of a cubic foot of solid coal at 80 pounds, which is the weight of a coal having a specific gravity of 1.282, within a fraction,—the yield would be, 108,865,152,000 pounds, or, 54,432,576 tons, or, 1,860,814,400 bushels, allowing 25 bushels to the ton. Throw-off one fourth for waste and slack, this would still leave 40,824,432 tons; this at a profit of four cents per bushel, or $1 per ton, would equal amount of tons in dollars.

By sinking shafts from 200 to 236 feet, the two other beds of coal, under the five feet bed, could be reached over the same sections of land, which would yield more than half as much more coal.

But this is by no means the total amount of coal lands in the Company's property.

Still beneath the four feet bed, there are numerous other beds, three and perhaps four of which are workable; these beds could also be reached by shafts extending from three to six hundred feet, under the four feet bed, on the east side of the Saline; but on the west side, they rise rapidly towards the surface by reason of the north-easterly dip, and can be reached in succession, at or near the surface, in a space of less than one mile, included between the Fish Dam on the Saline, and the Dutton Cliff on the south-west quarter of section 2, T. 11, R. 9,

These lower coals can be better seen on the sections measured on the Kentucky side, than on the Illinois side.

I therefore subjoin my measurements of thickness and intervening spaces, taken where there is the best opportunity of studying them in detail.

Four Feet Coal.

| | |
|---|---|
| Space . . . . . | 95 ft. to 100.0 |

| | | |
|---|---|---|
| Curlew coal, with clay partings, | | 1.0 |
| Total coal, | 2 to | 2.6 |
| Space, | 120 to | 140.0 |
| Ice house coal, | | 2.6 |
| Space, | | 160.0 |
| Bell's, | 3 to | 4.0 |
| Space, | | 75.0 |
| Cook's coal, | 3 to | 4.0 |

The last in the section (Cook's Coal), lies some 20 or 30 feet above the top of the conglomerate, which caps the mill stone grit series. This rock contains still another bed of coal, seen in the bluffs on the Ohio River, at various places between the mouth of the Saline and Battery Rock. Its thickness is variable, but usually in these bluffs, 26 inches. This is the coal of Battery Rock and the Union mines of Livingston County, Kentucky.

These lower coals, including the three and four feet beds, are accessible over an area of about 5,720 acres. Putting their united thickness at eighteen feet, and the weight of a cubic foot at 80 pounds, the yield would be 358,795,308,000 pounds, equal to 179,397,504 tons, or 4,484,937,600 cubic feet, or bushels of 80 pounds, which is 4 pounds over the legal standard. Throwing off one fourth for waste, slack, &c., and allowing a profit of three cents per bushel, on this coal, as being less accessible than the upper beds, we still have $100,911,084.

In this calculation, I have not included the numerous thin coals interstratified in these measures. The vertical diagram, together with the Geological section accompanying this report, from the highest coal of the Saline mines to the conglomerate of Dutton's Cliff, present in one connected view, the details of this stratification.

The thin coals are there laid down, as well as the main coals; also the thickness of the various intervening strata, the distances between the principal coals and the kind of rocks occupying these spaces. It will be perceived that many of the intervals occupied by shales, include also iron-stones.

I would here especially call attention to five of these spaces, filled with shales including iron-stones; the 12 feet of space over the 4 inch coal; the shales under the Curlew coal; the shales over the Ice-house coal; the shales above and below the five feet coal, and the shales under the building stone, and between it and the shales that cover the two inch coal, overlying Bell's coal. The three first of these are, probably, the most important receptacles of iron-stones on the property of the Saline Coal and Manufacturing Company.

The ores included in these spaces, are principally carbonates of the protoxide of iron, more or less bituminous, and containing variable quantities of earthy matter.

The best section exposed, of the shales overlying the four inch

coal, is in the bank of Turkey Creek, near its confluence with Saline Creek, on section 20, T. 10, R. 9.

In a space of 12 to 14 feet, immediately over the 4 inch coal, exposed on that stream, there are no less than five bands of carbonate of iron, amounting in all to, from 14 to 17 inches in thickness.

| | | ft. in. |
|---|---|---|
| 1st. | Carbonate of iron, | 0.2½ |
| | Black shale, | 2.6 |
| 2d. | Carbonate of iron, from 4 to | .6 |
| | Black shale, | 6.0 |
| 3d. | Carbonate of iron, | .3 |
| | Black shale, | 1.0 |
| 4th. | Carbonate of iron, | .3 |
| | Black shale, | 4.0 |
| 5th. | Carbonate of iron, | .2 |
| | Black shale, 2 to | .3 |
| | Coal, | .4 |

At this locality, tons of carbonate of iron might be collected at present, in the bed of the creek, which have fallen out from the disintegrating shales.

All the heads of the branches, and many of the ravines on the east side of the Saline, between the mouth of Turkey and a point opposite the Chamberlin Tip, show debris of these iron-stones, washed out from the shales extending over the greater part of section 20. It is also to be remarked, in regard to this locality, that there is very little earthy covering over the shales, so that, in many places, five or ten feet of stripping would suffice to lay the iron ore bare. I found large quantities of the same kind of ore amongst the loose rocks in Round Hill branch, above where the four inch coal is exposed, which proves the existence, at this locality also, of the same bands of calcareous iron-stones, disseminated in the shales occupying this geological horizon on the north side of the Saline; these can be reached also, in many places, between the Chamberlin mine and Round Hill, from 15 to 20 feet, under the subsoil of the bottom land skirting the base of the hills.

The specific gravity of this ore is 3.61, a chemical analysis yielded the following proportions:

| | | | |
|---|---|---|---|
| Water, | H | = 7.0 | |
| Bituminous matter, | | = 0.8 | |
| Insoluble silicates, chiefly silicate of alum, | | = 22.0 | |
| Carbonic acid, | C | = 23.95 | |
| Protoxide of iron, | Fe | = 35.37 | = 27.487 Fe |
| Magnesia, | Mg | = 5.8 | |
| Lime, | Ca | = 3.0 | |
| Alumina, | Al | = 2.0 | |
| Loss, | | .8 | |

This ore is essentially, a carbonate of the protoxide of iron, which is capable of yielding from 27 to 28 per cent. of metallic iron. If these bands of carbonate of iron are coextensive with the shales overlying the four inch coal, which there is every rea-

son to believe, from the data already furnished, this deposit of stratified ore is sufficient, in itself, to supply a furnace; since in Scotland, as Mushet informs us (p. 63, of his work on iron), experience has demonstrated that, "the attainment of a band of good iron-stone four inches thick, will sufficiently defray the expense of the operation." The same author further states, "strata of iron-stones are from half an inch to twelve inches in thickness. Those of 3, 4, 5, and 6 inches, are most commonly met with; they are also reckoned to contain a quantity and quality of iron superior to large bands." These stratified ores are worked, either by stripping or by galleries, "undercover," depending upon their proximity to the surface, and the dip of the strata.

While on this subject, I may remark that iron-stones somewhat similar in composition, are found in balls or segregations of compressed spherical forms in shale—*lunker-stones*—equally capable of being worked as the iron-stone bands. These "*lunker-stones*" occur very much after the manner of the great ball-stones in the roof of the Woodward mine. Often, it is true, they are too pyritiferous (impregnated with sulphuret of iron) to be wrought into good iron in the furnace; but this is by no means the case with all such ball-stones, and much of this kind of ore, of good quality, may be expected to be found on the property; perhaps, even in driving the entries into the coal seams.

With this description of ore may be classed an ore which we discovered on the south side of the Saline, nearly opposite the saw-mill. To prove the quantity of this ore, a pit was sunk to the depth of 6 to 8 feet in the shales; and the iron-stones being taken out, and thrown into one pile, and the imbedding shale pitched to itself in another heap, in the first four feet the whole excavation was estimated to yield from one fourth to one sixth of ore, chiefly in the form of flattened spheroids weighing from ½ to 2 or 3 pounds, of a grey color internally, having external concentric coatings of a pale ochry hue.

In the lower 3 or 4 feet of the excavation, where the shale was blacker and more bituminous, the included iron stones were mostly of a dark, leaden grey color; but more abundant, about ½ of the excavated mass.

The specific gravity of the first variety of iron-stone is, 3.206; an analysis yielded the following ingredients:

| | | | |
|---|---|---|---|
| Water, | H | = 1.9 | |
| Earthy silicates, insoluble in hydro. ac. | | = 11.0 | |
| Carbonic acid, | C | = 25.2 | |
| Protoxide of iron, | Fe | = 35.2 | = 87.9 Fe. |
| Peroxide of iron, | Fe | = 7.9 | |
| Lime, | Ca | = 4.7 | |
| Magnesia, | Mg | = 5.4 | |
| Alumina, | Al | = 4.0 | |
| Bituminous matter and trace, | | | |
| Alkalies not estimated, | | = 4.7 | |
| | | ——100.0 | |

The specific gravity of the second variety of iron-stone is, 2.987. The analysis of it yielded:

| | | |
|---|---|---|
| Water, | H = | 1.0 |
| Insoluble earthy silicates, | = | 36.0 |
| Carbonic acid, | C = | 22.6 |
| Protoxide of iron, | Fe = | 23.4 = 18.2 Fe |
| Lime, | Ca = | 5.38 |
| Magnesia, | Mg = | 3.6 |
| Alumina, | Al = | 0.4 |
| Bituminous matter, | C = | 3.5 |
| Loss and alkalies not estimated, | = | 4.12 |
| | | ——100.0 |

The former of these ores will yield, in the furnace, 33 per cent. of metallic iron, the latter 18 or 19 per cent.

In the bed of Round Hill branch, where the four inch coal crops out 63 feet above the three feet coal, it is covered by black indurated shale, which includes a species of black band, from one foot to eighteen inches in thickness; its specific gravity is, however, but 2.87.

The chemical analysis gave:

| | | |
|---|---|---|
| Water, | H. = | .8 |
| Insoluble earthy silicates, | = | 7.5 |
| Carbonic acid, | C = | 38.0 |
| Bituminous matter, | = | 4.5 |
| Lime, | Ca = | 25.2 |
| Protoxide of iron, | Fe = | 9.9 = 7.7 Fe |
| Magnesia, | Mg = | 11,4 |
| Alumina, | Al = | 1.8 |
| Loss of alkalies not estimated, | | .9 |
| | | ——100,0 |

It appears by this analysis, made upon an average specimen, that it only contains from 7 to 8 per cent. of metallic iron, over 25 per cent. of lime, the main base; hence it is more a bituminous carbonate of lime, than of oxide of iron.

But though the specimen obtained at this locality cannot be regarded as a workable black band ore, yet this geological horizon may nevertheless yield some profitable ore of this kind, in some portion of its extension, for I find, where such ore exists, that the per centage of iron is variable, at different localities of the corresponding formations; being a good workable ore at one place, and containing only six per cent of iron at others.

One variety of the ore in the shales over the Ice-house coal, is very similar in appearance to the ore analyzed from the shales over the four inch coal; but has rather less specific gravity, viz. 3.135; another variety of coarser texture, and of a lilac grey color, has a specific gravity of 3.340; while a third variety of a fine texture has a specific gravity of 13.591.

By chemical analysis, the two latter yielded:

| | | | | | |
|---|---|---|---|---|---|
| SPECIFIC GRAVITY, . . | 3.340 | . . . | 3.591 | | |
| Water, . . . | H = 5.0 | . . . | .30 | | |
| Carbonic acid, . | C = 23.0 | . . . | 31.00 | | |
| Siliceous earth, . . | = 30.0 | . . . | 8.50 | | |
| Protoxide of iron, . | Fe = 36.0 | met. iron | 49.00 | met. iron | |
| Peroxide of iron, . | Fe = 4.7 | 30.2 | 5.60 | 48.76 | |
| Lime . . . | Ca = 1.0 | . . . | 1.25 | | |
| Alumina, . . . | Al = 0.2 | . . . | 1.50 | | |
| Carbonaceous matter, | = 0.0 | . . . | 0.85 | | |
| Magnesia, . . | trace | . . . | 1.00 | | |
| Loss & alk. not estima. | 0.1 | . . . | 1.00 | | |
| | ——100.0 | | ——100.0. | | |

These ores will therefore yield from 30 to 43 per cent. of pure iron. The quality of iron which these carbonates produce, is similar to the metal brought from Jackson and Lawrence Counties, Ohio, and Greenup County, Kentucky. Where I have seen the best section of the matrix of these ores, they lie in interrupted bands, varying from one to four inches thick, in the ten feet of grey shales immediately overlying the Ice-house coal.

There are from seven to eight bands, which have an average thickness of two inches to two inches and a half; i. e., about one-sixth of the ten feet of ferruginous shales may be regarded as calcareous iron-stones.

Besides the above ores interstratified in the coal measures of Gallatin County, Hardin County affords extensive deposits of hydrated brown oxide of iron, or hematites, forming the various varieties known to the iron masters under the names of honeycomb ore, pipe ore, pot ore, etc. These ores occur in a different geological formation from those previously described, being uniformly in connection, though never interstratified with the subcarboniferous limestone lying west of the coal measures.

(To be continued.)

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## ART. V.—DRY DISTILLATION OF COAL AND ITS PRODUCTS.

THE various articles known as fuel consist of certain chemical combinations which can exist only within certain limits of temperature. By the application of heat the chemical equilibrium among the elements is destroyed, and the result is merely an overthrow of their existing arrangement, while an immediate re-arrangement ensues with the formation of new compounds capable of existing at the higher temperature. The nature of the new products is therefore mainly dependent upon the temperature, and these must vary in quantity still more than in quality as it is raised or depressed; while the admission or exclusion of air during the process will still further modify the result. When air is admitted, the

elements of these products are forced to combine with the oxygen of the air, and combustion results as a secondary product. On the other hand when the decomposition by heat is effected without the admission or access of air, the process becomes what is called *dry distillation.* The products of this operation can be conveniently collected and examined, and the process is worthy of particular attention, because it is instrumental in producing an important transformation of certain species of fuel.

The main points in this process of dry distillation, or decomposition by heat in closed vessels are the following: From the moment in which the elements are forced by the heat to abandon their former state of equilibrium, three circumstances concur in regulating the formation of the new products. These are: first, the temperature; second, the degree of chemical affinity among the elements, increased by their being in a nascent state; and third, their volatility. Hydrogen and oxygen possess volatility in a high degree, while carbon is not in the least volatile; there is a tendency, therefore, in the former to separate and pass off in the form of gas, but chemical affinity exerting its force compels them to unite and form new compounds, partly with each other, partly together or separately, with carbon. Those combinations will result, therefore, in which the elements have the strongest affinity for each other, under the circumstances and the existing temperature. Hydrogen and oxygen combine in the simplest and most stable manner to form water; the excess of hydrogen which is common to all fuel, takes up as much carbon as the temperature admits of, forming light carburetted hydrogen and olefiant gas, while at the same time the united action of the two other elements upon the carbon, gives rise to a series of ternary compounds. The simultaneous production of all these bodies gifted with powerful chemical affinities at a high temperature, induces fresh activity, and products of a subsequent action are the final result. In short, the nature of the process admits of the production of an almost innumerable series of bodies, as many perhaps as there are mathematical combinations, binary and ternary, for every degree of temperature. Many of these products are formed in every case of dry distillation.

Some of the results of dry distillation from various kinds of combustible are as follows: From the distillation of wood, there is obtained charcoal and permanent gases and vapors which condense into liquids at the ordinary atmospheric temperature. Two distinct liquids are constantly obtained, which separate into layers in the receivers. The *tar*, which is the heavier, is of a brownish black color, thick, opaque, of a peculiar odor, and composed of a number of substances as yet very imperfectly known. Some of these are volatile oily bodies, as empyreumatic oil, pyrelain, pyrostearine, and hold in solution another class of substances which have a strong resemblance to the vegetable resins,

as empyreumatic resin and pyrretine. This solution also contains extractive matter and many of the substances hereafter named, especially acetic acid. Paraffine has also been obtained from beech wood tar. The lighter liquid consists of an aqueous solution of numerous substances, some of which are likewise very imperfectly known as xylite, lignon, and mesite; others have been more fully investigated, among which are acetic acid, wood-spirit, acetate of methyl, creosote, and acetone.

The dry distillation of peat yields paraffine, oils, pyraligneous acid, pyroxylic spirit, and ammonia. The crude products of the distillation are tar, water, and gas, the ashes of the peat by some processes fluxing and flowing out as slag. A hundred tons of peat are said to yield six million cubic feet of gases, 10,000 to 12,000 gallons of water, and 300 to 350 lbs. of paraffine.

The paraffine thus obtained is essentially the same as that obtained from beech wood. Both are alike valuable for making candles. The following is the analysis of paraffine obtained from beech wood, peat, and boghead coal.

| | Beech. | Peat. | Boghead coal. |
|---|---|---|---|
| Carbon, ..... | 85.22 | 84.45 | 84.4 |
| Hydrogen, ..... | 14.78 | 14.83 | 14.87 |
| Oxygen or loss, | .... | .72 | 0.73 |
| | 100.00 | 100.00 | 100.00 |

We present in this connection the analysis of both beech wood and peat. The beech was dried at 284° F.

| | Carbon. | Hydrogen. | Oxygen. | Nitrogen. |
|---|---|---|---|---|
| Beech, ..... | 51.08 | 6.23 | 41.61 | 1.08 |
| Peat, ..... | 60.47 | 6.09 | 32.54 | 0.88 |

Boghead coal, 7.73—volatile matter, 69.70—ash, 22.57.

We notice the Boghead coal, as it is that which has been principally used in England for the manufacture of paraffine.

In the last number (January) of this magazine will be found analyses of all the cannel coal used in Great Britain for gas purposes. It is that species of coal which is richest in volatile products in connection with carbon that appears to be most suitable for distillation. For the products of the dry distillation of coal, we must likewise refer to the same number of this magazine. They are to numerous to be repeated here. In the distillation of suitable coal the most extensive product, apart from gases, is a species of oil very useful for lubricating purposes—by re-distillation and purification other products are obtained—paraffine, &c. The Breckenridge Coal Company, whose mines are in Kentucky, have turned their attention to an extensive distillation of their coal. From a ton, it is stated that "one hundred and forty gallons of a crude oil can be obtained, which by subsequent re-dis-

tillations and purification will yield thirty gallons of benzole, fifty gallons of good lubricating or burning oil, and twenty to thirty pounds of paraffine—thus making the product of one ton of the coal, which has a ready sale, worth about one hundred dollars." This is a great yield, especially of paraffine. We have not, at hand, the results of the distillation of coal elsewhere, and the nearest approach to them is a statement of results from the distillation of peat—a very insignificant article as compared with this species of coal. Still the products are large:

| Peat. | Sulphate ammonia. | Acetate lime. | Naphtha. | Paraffine. | Oil volatile. | Oil fixed. |
|---|---|---|---|---|---|---|
| 100 tons yielded,.... | 1 ton | 14 cwt. | 52 gall. | 350 lbs. | 200 gall. | 98 gall. |

So also from wood the yield by distillation is large. Three cwt. ash dried at 212° F. yielded:

Crude liquor, 190 lbs.—bicarb. pot. 792 grains—acetate lime, 22 lbs.—charcoal, 90 lbs.

The process of distillation often makes considerable difference in the yield.

In general the available amount of the volatile and fixed matters of coal are estimated somewhat in the following order:

| | Naphtha. | Dead oil. | Pitch. |
|---|---|---|---|
| Common coal tar,..... | 3 | 62 | 35 |
| Ordinary cannel tar,..... | 9 | 60 | 31 |
| Boghead cannel tar,..... | 15 | 67 | 18 |

The following is the analysis of Breckenridge coal which has a large per centage of volatile matter:

| | |
|---|---|
| Gas or volatile matter,..... | 60.27 |
| Carbon in coke,..... | 31.05 |
| Ash,..... | 8.16 |
| | 99.98 |

The following comparative value of candles has been drawn up by Mr. Karsten, from experiments undertaken to test the value of paraffine candles made by Wiesman & Co., of Bonn:

| Kind of Candles. | | Grains of material light consumed in 4½ hours. | Light from an equal amount of material. | Illuminating value, or light obtained for a certain fixed amount of expenditure. | Relative price of material. |
|---|---|---|---|---|---|
| Paraffine, | 4 to the lb..... | 525 | 1.00 | 1.00 | 80 |
| Spermaceti, | 6 " " ..... | 540 | 0.826 | 0.62 | 40 |
| Wax, | 4 " " ..... | 552 | 0.45 | 0.519 | 26 |
| Artificial Wax, | 5 " " ..... | 642 | 0.76 | 1.066 | 21 |
| Ordinary Stearic acid, | 4 " " ..... | 822 | 0.543 | 1.018 | 16 |
| Tallow, | 6 " " ..... | 1020 | 0.45 | 1.35 | 10 |

At the prices existing under which this estimate was made, it would appear that paraffine could not compete with tallow and some of the finer materials for candles; but its great beauty,

which is quite equal to wax, and its perfect combustion without waste may be set against its somewhat higher relative value in the above table.

After all, the oil is the article of the most importance.

The manufacture of paraffine oil in England has already affected the price of sperm oil at least 25 per cent., and produced a substitute during a reduction of 50 per cent. in the importations. Such have been the results that the anticipation is there boldly expressed that this discovery of the production of paraffine oil by the slow distillation of coal, is destined to accomplish a marvellous change by superseding the hazardous fisheries in the Southern Ocean.

We present in this connection the following ultimate analysis of certain pure animal oils made by J. H. Alexander and Campbell Morfit.

| | Sp. gr. at 64°.5 F. | Elements. | | |
|---|---|---|---|---|
| | | Carbon. | Hydrogen. | Oxygen. |
| Winter sperm oil,..... | 0.87971 | 0.76490 | 0.12150 | 0.11360 |
| Lard oil,..... | 0.91646 | 0.76658 | 0.10586 | 0.12756 |
| Whale oil,..... | 0.92000 | 0.77511 | 9.11430 | 0.11059 |

In mixing these oils, and probably all animal oils, no change of volume occurs. The following are the specific gravities observed at and calculated for a temperature of 65°·25 F., equal volumes respectively mixed as under:

| Mixed Oils. | Sp. Gr. obsvd. | Sp. Gr. cal. |
|---|---|---|
| Winter sperm x lard,..... | 0.89786 | 0.89785 |
| " " x whale,..... | 0.89905 | 0.89962 |
| Lard x whale,..... | 0.91778 | 0.91750 |

If we assume as constant for all the mean of the respective factors of condensation from the original gaseous volumes into the volume of resulting liquid, we can calculate upon the specific gravity of said liquid the proportions of the elements it should contain. The following shows the result of such a calculation for the carbon of each of the above:

| | Sperm Oil. | Lard Oil. | Whale Oil. |
|---|---|---|---|
| Carbon calculated,..... | 0.76118 | 0.78367 | 0.75854 |
| Carbon found,..... | 0.76490 | 0.76658 | 0.75511 |

The differences here between calculation and experiment, amounting to 1 2-8 per cent. for lard and whale oils, and 3-8 per cent. for sperm, are attributable, 1st, to certain errors of observation; 2d, to possible error in assuming the factor of condensation as constant in the different kinds of oil; and 3rd, to probable physical variations in the constitution of different samples of the same oil. These variations may, however, be taken provisionally as covering the whole margin indicated by the above differences.

The value of oil and whalebone in a crude state obtained from the seas during some years, has reached $7,000,000, which by manufacturing has been increased to $9,000,000. The value of the whalebone included in this amount was about half a million dollars. The gross amount stated above is about the average for many years. Under the great and constantly increasing demand for oil for illumination, for lubricating purposes on railroads and machinery, and other purposes, there is no question but an extensive field is open for enterprise in the extraction of the products of coal. In Europe this branch of business has proved exceedingly profitable, and become the salvation of some of the peat companies of Ireland.

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## Art. VI.—CENTRAL AMERICA—NICARAGUA AND ITS MINES.

No territory not belonging to the United States can possess a greater interest to its citizens than portions of Central America. Across the Isthmus are the two routes from ocean to ocean, which present to the numerous travellers to and from California the great feature of interest and novelty of the long passage. Thousands who have passed by the Transit Route through the Lakes Nicaragua and Managua, and suffered from the vexations and annoyances of the earlier arrangements, though vexed besides by the plagues of the tropical rains and tropical insects, multiplied by the half barbarous character of most of its inhabitants—still these look back with a kind of longing regret towards its luxurious climate and luxuriant groves; and would fain again partake of its rich fruits, and again bask in the warm rays of its tropical sun, and under the brighter glances of its gentler senoritas. As the great link that is to connect the two oceans and open the short passage to the East desired by all commercial nations ever since the East was an object for commerce, it is to us a most important national interest; indeed it is a matter of serious concern by what power the future gates of the commerce of the world shall be controlled. For such reasons do the resources and peculiarities of this region possess especial interest; and it shall henceforth be our object to present to our readers all the particulars we may be able to gather from reliable sources relative to the climate and productions of this country, especially those of a mineral nature. With this view we have prepared the accompanying map of Nicaragua, for convenient reference.

So interesting a region has not lacked explorers, nor those possessed of great ingenuity of description; but when we find in documents addressed to the government of the republic expres-

sions such as this—"that the State possesses in this beautiful district an inexhaustible treasury of immense riches; wealth consisting of Madeira wood and common cedar, mahogany, ebony, granadillo, &c., and also of beautiful cattle that increase wonderfully; wealth of pasture and tillage land, mines of gold, silver, copper, lead, coal, and all other rich productions known to the geologist, only to be properly described in poetry," we are inclined to exercise particular care in sifting the real prose out of the very exuberant literary productions, to which this wonderful region has given birth.

Our present remarks will be limited to the independent republic called Nicaragua; and it is a matter of regret that the geological descriptions of this great region should be so meagre, and afford such unsatisfactory reports of its mineral resources, which, from such accounts as we have, really appear to be of no little importance.

The territory claimed by this State, including the Mosquito Coast along the Atlantic, comprises an area of about 59,000 square miles, according to the statement of Mr. E. G. Squier, in his work upon Nicaragua. Its position (by the same authority) relatively to the bordering states of San Salvador and Honduras on the north, and of Costa Rica on the south, is seen by reference to the map. So are also its position in latitude and longitude, and the great features of its topography. A range of mountains known as the Alto Grande, the continuation of the Cordilleras of Mexico, enter the territory on its northern border, and extend in a southern course parallel with the Pacific coast, and about one hundred and fifty miles back from it to the Atlantic shore, on the borders of Costa Rica. Another parallel range skirts the Pacific coast, and its spurs form groups which alternate with the broad plains and broader lakes, that are spread out between the two ranges. Along the western ranges are many volcanoes, some of them moderately active—their greatest height being about 6,000 feet above the sea.

Omitting for the present any reference to the mines of the eastern range, the great central basin between these mountains comprises the objects of especial interest in the region. It is stated, by Mr. Squier, to be not far from three hundred miles long by one hundred and fifty wide, and to be well watered by the streams, whose sources are in the mountains on each side. Its north-western extremity abuts upon the Gulf of Fonseca, which opens into the Pacific, though its position and the barrier of islands on the range of the Pacific group of hills, suggest that it was once but another inland lake similar to Lakes Managua and Nicaragua, ranging with it towards the south-east. Its distance from the former of these is about seventy miles; broad and beautiful plains intersected by a range of volcanoes stretching from the "gulf to the lake. Lake Managua is described, by Mr. Squier, as a beau-

tiful sheet of water, not far from fifty or sixty miles in greatest length by thirty-five in width, and ranges from two and three to fifteen, and even forty fathoms in depth. The scenery which borders it is unsurpassed in beauty and grandeur. Upon the northern and eastern shore, lifting their blue, rugged peaks, one above the other, are the mountains of Matagalpa, merging into those of Segovia, rich in metallic veins. Upon the south and west are broad and fertile slopes and level plains, covered with luxuriant verdure, and of almost unlimited productiveness. The volcano of Momotombo, like a giant warden, stands out boldly into the lake, its bare and blackened summit, which no man has ever reached, covered with a light wreath of smoke, attesting the continued existence of those internal fires which have seamed its steep sides with burning floods, and which still send forth hot and sulphurous springs at its base. Within the lake itself rises the regular cone of Momotombita, so regular that it seems a work of art, covered with a dense forest, under the shadows, and within the deep recesses of which, frayed by the storms of ages, stand the rude and frowning statues of the gods of aboriginal superstition, raised there long before European feet trod the soil of America, and to which the mind of the Christianized Indian still reverts with a mysterious reverence."*

The elevation of this lake above the Pacific is one hundred and fifty-six feet—the shortest distance across the hilly strip of land that separates the two waters, is about fourteen miles. There is no open outlet to the lake. Its surplus waters escape by evaporation, and hence it must be filling up.

Lake Nicaragua, commencing a few miles further towards the south-east, stretches in this direction about one hundred miles, with a width estimated at about fifty. Its outlet is the river San Juan, a stream about ninety miles in length, connecting this basin with the Atlantic Ocean. At its mouth is the town of San Juan del Norte, or Greytown, the depot of the Transit Company, and the settlement of Col. Kinney. Chagres and Aspinwall, on the route to Panama, lie three hundred miles farther to the south.

Where the river San Juan crosses the range of the Alto Grande Mountains its navigation is obstructed by a series of rapids, a considerable part of the fall of one hundred and twenty-eight feet being concentrated within a few miles. These, however, are now overcome by the river steamers of the Transit Company, and the passage to a port on the Pacific, called San Juan del Sur, opposite the lower portion of Lake Nicaragua, is made in a day and a half; the distance being reckoned at one hundred and twenty-two miles. The staging across from Lake Nicaragua to the Pacific is only twelve miles.

* Nicaragua—Its People, Scenery, Monuments, &c.; p. 25.

Granada and the other principal towns of Nicaragua, are situated near the lakes within the central basin. The larger portion of the cultivated lands also lie here, though the farming tracts of the Kinney colony are along the valley of Indian River, on the north side of the Alto Grande Range. The necessary articles of subsistence, as plantains, beans, wheat, and corn, are raised in abundance, with very little care; but there is a great want of mills for grinding, and, indeed, of all other machinery. The tropical fruits are every where procured in their numerous varieties and great profuseness. Cattle roam in herds of many thousands over the plains; and they are said to be equal in quality to those of the States. The general healthfulness of the country is very good, except of the low lands lying along the Atlantic coast. In the central basin sickness seems to be no more prevalent than in other countries of a good reputation for health.

The year is divided into two seasons only—the wet and dry—the former usually beginning in May and ending in October. Near the Atlantic coast during this period, the rains fall sometimes for weeks together, with only varying degrees of profuseness. But coming with the trade winds from the north-east, the clouds part with the greater portion of their moisture before they have crossed the mountains; so that much less rain is precipitated upon their south-western slopes, and in the central basin. The wet season here is neither unhealthy nor disagreeable. Rains and thunder gusts are frequent in the latter part of the day; and are followed by nights of the most agreeable temperature. During the day the thermometer ranges but little, for weeks together, beyond the limits of 80° or 85°

In the dry season the rapid growth of vegetation is checked; the streams dry up; the soil becomes parched, and the roads and streets dry and dusty. Cattle suffer for the want of water, and their summer feeding grounds are deserted in search of it. Northerly winds prevail at this season, which bring a chilly temperature with them, very sensitively felt even by those from colder climates, where the temperature ranges for long periods many degrees below the lowest point ever reached here. The highest summits of the mountains, however, are not unfrequently white with snows. The mountainous portions of the country appear to be less subject to the droughts of the dry season than the lower districts. The accounts we have seen of visits made to the mines at this season generally make mention of showers more or less frequent and copious.

The mining region is along the range of the Alto Grande Mountains, principally on the south-western slopes. In Honduras, upon this same range farther north, the mines have been better known and more productive; but in the district of Segovia bordering on Honduras, and also near the town of Matagalpa, and

in the district called Chontales, gold mines have been worked by the early Spanish settlers, and their rude machinery is still kept going to some extent by the native Indians. Ruins of many ancient arrastres are narrated as still to be seen along the streams for many miles about Matagalpa. The machinery was too imperfect to work any but the softest material; which, from the meagre descriptions we have, appears to be slates, which have decomposed to a reddish-colored earth, in which the gold is too fine to be visible. The quartz found with the red earth, on account of its hardness, is not ground in the arrastres. The gold appears to be considerably alloyed with silver. We have no accounts of deposit gold ever having been collected in any quantity in this region—a fact which, with many, would add to the probability of the vein-mines being likely to prove very productive.

In the Chontales district the mines are in the vicinity of the village of Libertad, on the rivers Mica and Bola, which are branches of the Bleufields River. The distance from Santa Clara at the northern end of Lake Nicaragua, and thirty miles from Granada, is only thirty-five miles to Libertad. The village of Guigalpa lies on the route, about fifteen miles from Santa Clara. The mines are all quartz-veins, ranging from six inches to four feet in thickness; the veinstone so much decomposed that five tons per day can be ground (to what degree of fineness does not appear) in one of the arrastres of the country. These machines, well known to all conversant with gold mining, are tubs with stone bottoms, around which heavy stones attached to a horizontal arm, are dragged by mules or water power. A portion of the gold is caught by the mercury put in the tub: but unless the materials are ground very fine the greater part of the gold flows off with the water. In a report of the Chontales mines addressed to Hon. J. W. Fabens, by Geo. H. Campbell, Esq., from which the data relating to this district are mostly collected, the writer expresses the opinion that an average of about two ounces of gold may be collected from each ton of ore ground. This would be not far from a dollar and a half to the bushel. Ores not sulphurous pay well in the Southern States if they yield one tenth this amount.

It is reported that there are several silver mines between Libertad and Lake Nicaragua, but we have no authentic accounts of them.

If the opinions expressed of the richness of the gold mines should be confirmed in further explorations, here is a region of great extent, that possesses many attractions over the mining districts of California, and which, under an administration favoring emigration, is likely to be overrun by a numerous population of our own countrymen. The climate of the mountains is probably unsurpassed throughout the year. The surface is covered with a growth of excellent timber, among which are found

the pine and oak of Northern States. Grass grows luxuriantly, so that cattle and horses find the best of grazing both on the plains and on the mountains. The fruits of the tropics and of the temperate zones are met with in close proximity, and of the greatest variety—and nowhere, probably, can the chief articles of subsistence be more cheaply obtained. Though the country itself is rude and unprovided with roads, and with many things deemed essential in a civilized region, still it is near large cities, and upon what has now become one of the great thoroughfares of the globe. Let its political condition become settled, and the character of its population must change rapidly, as has that of California.

We regret that we cannot furnish more particulars concerning the geology of the country, and its resources in other minerals than gold. The interior basin appears to be wholly of a volcanic character. Basaltic rocks and lava with limestone, and a calcareous breccia partly made up of volcanic products, are the only rock formations of which we have seen any account. A dense vegetation covers the surface almost every where, which, in the uncultivated portions can be penetrated only by cutting one's way through the thickets with the macheta or sword.

In the mountainous districts the rocks are the quartz, and the slates such as are found in all gold regions. Here the undergrowth is open, and the country is more easily explored. Though reports of the existence of coal have been circulated, we have seen nothing that would lend to such reports any credibility, and we have little faith that mines of it will ever be found. Still as they occur along the slopes of the Andes in Chili and Peru, the formation may possibly come in between the igneous rocks of the mountains and the coast. More extensive explorations are required to enable the geologist to positively assert that it cannot be found.

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## COMMERCIAL ASPECT OF THE MINING INTEREST.

NEW YORK, *January* 31, 1856.

The money market, which was so pressed at the close of last month, with a heavy demand, has become satisfactorily easy, and borrowers can obtain all they want. Discount rates range from 7 up to 10 per cent., according to date and class, and call loans 6 to 7 per cent.

In the stock market generally there has been throughout the month but little doing, either for investment or speculation; and in mining stock, save and except a few coal stocks, positively nothing. Outsiders are not buying, and the business doing is only the necessary result of settlement of maturing contracts.

The home circumstances of the market are all satisfactory. The country is prosperous, rich in products—cotton, grain, and gold; but the fears which prevail about financial matters in London and Paris check the buoyant feeling which home prosperity has a tendency to give rise to.

The Bank of England, it is feared, will further raise the rate of interest, and large loans may be yet required by the governments of England and France, which may in some degree check matters here. The war in Europe has already diminished emigration to this country, and we do not benefit so much as we did, by new labor, and by the capital which emigrants bring.

The Copper mines of Lake Superior take the lead in productiveness. One of these, however, the Norwich Company, has made a further assessment on its stockholders, calling for the contribution of a dollar per share, payable on the 15th of February.

The Cliff mine has declared a half yearly dividend of ten dollars per share. In May, 1849, this Company paid its first dividend of ten dollars per share. In February and August 1850, two dividends of seven dollars each In February and August 1851, two dividends of five dollars each. In February and August 1852, two dividends of five dollars each. In February and August 1853, two dividends of seven dollars and a half each. In February and August 1854, two dividends, one of ten and one of eight dollars. In February and August 1855, two dividends, one of five and one of eight dollars. In February 1856, one of ten dollars; together $100 per share, in seven years. There are 6,000 shares of this Company. Of Minnesota the shares number also 6,000, on which, in five years, has been paid $520,000 in dividends; the par value being $18,50 per share; and the Company has a surplus of $38,000, and real estate, and workhouses, and stocks, valued at $37,000.

An assessment of five cents per share has been made on the stock of the South-East Cliff Mining Company, payable at the Company's office in Detroit, on the 4th February.

Many holders of stock in the What Cheer Mining Company, and in the Eureka Iron Company, have forfeited their interest from non-payment of assessments, and sales of the forfeited shares will be made at Detroit by auction, on the 14th and 15th February next.

Of the Coal stocks, Cumberland Coal Stock is the most productive, and has the greatest prospect. The Directors of the Providence and Worcester Railroad Company have reported in their recent annual communication to their stockholders, that they "had caused an experiment to be made in the use of bituminous coal for locomotives, and an engine constructed was on trial, running daily on the road, which has so far succeeded as to warrant the expectation that coal engines may be introduced so as to save nearly one half of the present cost of fuel, or an annual sum of not less than one fourth per cent. of the Capital stock of the Company." This is important, as bearing on the substitution of coal for wood in locomotives; and promoting the use of coal. The Providence and Worcester road is using Cumberland coal. The steam interest, both land and marine, are the great customers of the Cumberland Coal Company.

The Reading Railroad Company has just made its annual report. The profits of the year 1855 are greatly in excess of those of 1854; and also exceed the estimate by $100,000. This has been obtained, although unusual expenditures occurred. The stock has been augmented during the year by $115,050 for construction expenses, and by $2,131,000 for conversion of bonds into stock last July. The floating debt stands at $675,383,11.

| | |
|---|---|
| The receipts of the road for the year ending 30th November were | $4,321,793 86 |
| And the expenses, (40 per cent.) | 1,727,878 62 |
| Leaving the large gross profit of | $2,593,915 24 |
| Interest on the bonded debt, | 653,509 48 |
| Dividend fund | $1,940,405 79 |
| July dividend and sinking fund payment and tax | 824,557 46 |
| For the January dividend | $1,115,848 30 |

Compared with 1854, the result is stated as follows:

| | 1855. | 1854. |
|---|---|---|
| Gross receipts, | $4,321,793 84 | $3,781,689 91 |
| Expenses | 1,727,878 62 | 1,641,212 94 |
| Renewal fund | 149,482 48 | 129,988 76 |
| Balance to meet interest and dividends, | 2,444,432 74 | 2,010,488 21 |

The surplus after payment of the cash dividend of four per cent. is $539,121,57 applied towards the payment of the floating debt, but for which the stockholders received two per cent. dividend report.

We learn that the track of the Delaware, Lackawanna and Western Railroad has been laid to the Delaware River, five miles below the water gap, and that the first locomotive crossed the bridge on the 21st instant.

The Tunnel on the Warren Railroad is so nearly completed, that it is expected the cars will pass through to Elizabethport, by the 1st March next. The road is now finished 111 miles from Great Bend, where it unites with the Erie Railroad, to the Delaware River. The Warren Extension road, eighteen miles long from the Delaware River to New Hampton, on the New Jersey Central Railroad, is also all finished except the Tunnel at the Gap, near the river, and when this is finished, as it will be on the 1st March, the company will be prepared to bring coal through to Elizabethport. The Company's mines are situated about half the length of the road, dividing into two parts, north and south of Scranton, at which point the road cuts the coal-field into parts, east and west of Scranton. Great Bend is about fifty miles north of Scranton, and the Delaware crossing sixty-one miles south.

The Company mined and forwarded 190,000 tons last year to market, in the North and West, and to Canada, being an increase of 60,000 tons over the year 1854. The Company's present main depot is at Ithaca, where it has now a stock of 37,000 tons for western and northern consumption. The Company lease the Cayuga and Susquehanna Railroad, which connects Ithaca with the Erie Railroad, and its coal is taken thence by canal to Syracuse, Rochester, Buffalo and Canada.

| | |
|---|---|
| The company realized last year from its sales of coal . . . . . | $182,446,78 |
| And from transportation, &c. . . . . | 254,925,17 |
| | $437,365,95 |

which was sufficient to pay the year's interest on its bonds and stock, besides the ordinary expenses of mining and operating the road, and leaves a surplus of $8,585,55.

The cost of the road has been thus far $6,084,281,47, including the sum of $2,687,836,66 on the southern division, from Scranton to the Delaware, which has not yet been productive.

| | |
|---|---|
| The stock in 61,020 shares amounts to | $3,051,000 |
| Funded debt | 2,400,000 |
| Floating debt | 600,000 |
| | $6,051,000 |

The company will shortly issue its bonds to provide for the expenses of completing the work, which, when finished, will supply the New York market with a large additional quantity of coal.

We learn from the Washington Silver Lead Mine, situated in Davidson County, North Carolina, that from 1695 pounds of the lead, 121 ounces of bullion were obtained, and 7 ounces of gold,

The annual Report of the Breckenridge Coal Company states that they have sold over $100,000 of coal during the last year. They have about 4000 acres underlaid with cannel coal. From 120 to 130 tons are mined daily at $1.25 per ton. A railroad to the Ohio, eight miles and a half, is in operation. The extent of openings is 2,839 yards. The expenses of the last year have been $210,081. The Report says: "In our estimation, the value of our whole property has been doubled by recent developments. It is now ascertained without a doubt that our coal is without precedent valuable for the manufacture of oils, benzole and parrafine, and that it soon will command too high a price to permit of its use as a fuel."

The Saline Coal and Iron Manufacturing Company, is receiving very flattering subscriptions to their increase of capital. The demand for railroad iron is so great, so reliable, and increasing with such rapidity, that it will be many years before the furnaces of the West can supply it. They will then have the monopoly as the cost of transportation, &c., will exclude the foreign article.

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## COALS AND COLLIERIES.

### ANTHRACITE COAL TRADE for 1856.

| | | |
|---|---|---|
| Shipments by Reading Railroad to Jan. 31st, | 167,057 12 | tons. |
| Same time last year, | 213,151 12 | " |
| Decrease, | 46,094 00 | " |

### MARYLAND COAL TRADE.

| | | |
|---|---|---|
| *Shipments to Feburary 16th,* | 8,218 13 | tons |

THE COAL TRADE OF 1855.

Very extensive and complete details, from official sources, of the Eastern Coal Trade for 1855, have been prepared by Mr. B. Bannan, of the Pottsville Journal, for which he is entitled to great credit. A summary of the results are as follows:

| | 1854. Tons. | 1855. Tons. | *Inc.* Tons. | *Dec.* Tons. |
|---|---|---|---|---|
| SCHUYLKILL REGION. | | | | |
| By Railroad,..... | 1,987,854 | 2,213,292 | 225,438 | |
| By Canal,..... | 907,354 | 1,105,263 | 197,909 | |
| Pinegrove,..... | *62,462 | *77,481 | 15,019 | |
| Schuylkill, total,..... .. | 2,957,670 | 3,396,037 | 438,366 | |
| WYOMING. | | | | |
| Lehigh Canal,..... | 1,207,186 | 1,224,842 | 17,656 | |
| Lehigh Valley Railroad,.. | | 9,068 | 9,068 | |
| LEHIGH REGION. | | | | |
| Delaware and Hud. Co.,... | 440,944 | 565,460 | 124,516 | |
| Pennsylvania Coal Co.,... | 496,648 | 504,803 | 8,155 | |
| N. Branch Canal,..... | 492,689 | 464,039 | | 28,650 |
| White Haven Railroad,.. | 39,232 | 50,209 | 10,977 | |
| Western Railroad,..... | 138,965 | 187,000 | 53,035 | |
| SHAMOKIN, ..... | 63,500 | 116,117 | 52,617 | |
| Anthracite, ..... | 5,831,884 | 6,517,569 | 715,385 | 28,650 |
| | | 5,831,884 | 28,650 | |
| Increase of Anthracite in 1855,..... | | 686,735 | 686,735 | |

Showing an increase of Anthracite Coal in 1855, of 686,735 tons, against 784,690 tons, last year.

| | 1854. Tons. | 1855. Tons. | *Inc.* Tons. | *Dec.* Tons. |
|---|---|---|---|---|
| SEMI ANTHRACITE. | | | | |
| Lykens Valley Co..... | 57,500 | 66,721 | 9,221 | |
| Short Mt. Co.,..... | 50,000 | 50,500 | 500 | |
| Dauphin Co.,..... | 63,000 | 1,000 | | 62,000 |
| BITUMINOUS. | | | | |
| Cumberland Region,..... | 648,299 | 664,304 | 16,005 | |
| Foreign Coal,..... | 252,865 | 287,408 | 34,543 | |
| | 1,071,664 | 1,069,933 | 60,269 | 62,000 |
| | 1,069,933 | | | 60,269 |
| Decrease in 1855,..... | 1,731 | | | 1,731 |

The increase of Semi-Anthracite, and Bituminous Coal in 1854, including Foreign, over the previous years, was 218,167 tons. This year there is a decrease of 1,731 tons, making the total increase of all kinds, in 1855, 684,004 tons, against 952,857 tons, in 1854. As the prices ruled high in 1854, and were much lower in 1855, there will, in all probability, be a clear market in the spring.

Of the increased supply of Anthracite, Schuylkill County furnished 438,366 tons, leaving 248,369 tons for the increase of all the other Anthracite regions.

Of the 6,517,569 tons of Anthracite, Schuylkill County, as usual, has furnished more than half, as the following figures will show:

| | |
|---|---|
| Whole supply in 1855,..... | 6,517,560 |
| Sent from Schuylkill,..... | 3,396,086 |
| Other Regions,..... | 3,121,533 |

It is exceedingly doubtful whether this county will run ahead of all the other regions this year, unless moderate rates of toll and transportation are established by the carrying companies.

* The quantity sent from the Pinegrove and Swatara Region in 1854 was 91,462 tons, and in 1855, 112,213 tons, but the balance is included in the Philadelphia and Reading Railroad report. It having been received from the Dauphin and Susquehanna Railroad.

COAL OPERATIONS.

The following is the aggregate quantity of coal shipped by each operator during the year 1855, from the Schuylkill Region.

| Operators. | Coll. | Total tons. | | Operators. | Coll. | Total tons. |
|---|---|---|---|---|---|---|
| R. Heckscher & Co., | 4 | 183,038 | | Kitzmiller & Stees, | 1 | 21,614 |
| E. Borda, | 1 | 92,169 | 313,495 | Wheeler & Miller, | 1 | 20,208 |
| David Glover, | 1 | 38,248 | | George H. Posts, | 2 | 19,898 |
| Brown & White, | 1 | 117,341 | | T. H. Wintersteen, | 1 | 17,244 |
| D. P. Brown & Co., | 2 | 33,566 | 158,791 | C. J. Dobbins, | 1 | 15,918 |
| J. Claude White, | 1 | 7,884 | | Daniel Edwards, | 1 | 15,705 |
| Charles Miller & Co., | 2 | 53,271 | | Titus, Alton & Co., | 1 | 15,352 |
| Charles Miller, | 1 | 35,715 | 141,509 | H. C. Harper & Co., | 1 | 14,773 |
| Adams & Miller, | 1 | 32,501 | | L. S. Spangler, | 1 | 13,623 |
| George Miller, | 1 | 20,022 | | Thos. Wren & Co., | 1 | 13,321 |
| G. Bast & Co., and L., Audenried & Co., | 3 | | 129,819 | J. Maginnis & Co,, | 1 | 12,980 |
| Wm. Milnes Jr. & Co., | 1 | | 120,894 | Hammer & Miles, | 1 | 12,777 |
| J. & R. Carter, | 3 | | 105,568 | Thomas Gorman, | 1 | 12,392 |
| John Tucker, | 2 | | 102,016 | David Oliver, | 1 | 11,433 |
| R. Kears & Co., | 2 | | 99,583 | Shultz & Brother, | 1 | 11,211 |
| Geo. W. Snyder, | 2 | | 94,000 | H. J. Osterman, | 1 | 10,907 |
| Wm. Johns, | 1 | | 82,565 | H. Guiterman & Co., | 1 | 10,729 |
| Kirk & Baum, | 3 | | 79,157 | William Rohrer, | 1 | 10,496 |
| Wm. Y. Agard & Co., | 2 | | 77,511 | Connor & Reads, | 1 | 10,379 |
| Jones & Cole, | 2 | | 75,643 | T. Garretson & Co., | 1 | 9,798 |
| Rogers, Sinnickson & Co., | 3 | | 74,092 | T. J. Atwood & Co., | 2 | 9,706 |
| Geo. S. Repplier, | 2 | | 70,095 | R. Williams & Co., | 1 | 9,674 |
| Jones, Mason & Spencer, | 5 | | 61,527 | Fisher & Co., | 1 | 9,568 |
| R. Ratcliffe & Co., | 1 | | 57,445 | B. Tyson & Co., | 1 | 9,229 |
| E. W. McGinnes, | 2 | | 52,594 | J. J. Williams & Co., | 1 | 9,214 |
| Heaton & Carter, | 1 | | 50,882 | Jonathan Wasley, | 1 | 9,193 |
| William Donaldson, | 1 | | 50,374 | John G. Hewes, | 1 | 8,290 |
| Gorden, Bedell & Co., | 1 | | 49,907 | E. Hammer & Co., | 1 | 7,962 |
| R. H. F. Horton, | 1 | | 48,005 | L. C. Dougherty, | 1 | 7,864 |
| F. J. Parvin, | 1 | | 45,865 | James Ebert, | 1 | 7,156 |
| John Doherty, | 2 | | 41,784 | W. H. Shaeffer, | 1 | 7,578 |
| Wallace & Rothermel, | 2 | | 40,186 | R. Holman & Co., | 1 | 6,785 |
| Sutton & Wright, | 2 | | 38,697 | Andrew Miller, | 1 | 6,733 |
| Graham, Brown & Co., | 1 | | 37,610 | A. Lawton, | 1 | 6,281 |
| Dolbin & Rogers, | 1 | | 36,317 | J. Reed, | 1 | 6,285 |
| F. Macdonald, | 1 | | 35,905 | Fritz & Seltzer, | 1 | 5,939 |
| James Neill & Co., | 1 | | 35,243 | Lewis Diehl, | 1 | 5,387 |
| John C. Neville, | 3 | | 33,461 | Molley, Newcomer & Co., | 1 | 5,344 |
| Jeter Bowman, | 1 | | 33,325 | Jenkins & Williams, | 1 | 4,903 |
| John Bancroft, | 1 | | 33,165 | Morgan Brace, | 1 | 4,901 |
| Beatty & Thomas, | 1 | | 32,122 | W. Montelius & Co., | 1 | 4,829 |
| George Spencer, | 2 | | 30,230 | W. J. Uhler, | 1 | 4,433 |
| J. B. McCreary, | 1 | | 30,172 | Capewell & Dovey, | 1 | 4,375 |
| Geo. Wiggan & Son, | 1 | | 28,935 | Allen & Compton, | 1 | 4,158 |
| Hammett & Co., | 1 | | 26,757 | H. J. Beachem, | 1 | 3,255 |
| A. Silliman, | 1 | | 25,860 | Edward Davies & Co., | 1 | 3,090 |
| Buery & Brooke, | 1 | 10,398 | | Grove & Leaver, | 1 | 3,078 |
| J. Buery & Brother, | 1 | 10,303 | 26,278 | Wm. Littlehales, | 1 | 3,033 |
| L. P. Brooke & Co., | 1 | 5,572 | | McCormick & Clark, | 1 | 2,733 |
| W. & C. Brittain, | 1 | | 25,336 | Riley, Eshlerman & Co., | 1 | 2,371 |
| McFarland & Verner, | 1 | | 25,111 | Adams, Powell & Co., | 1 | 2,329 |
| Meyer & Sillyman, | 1 | | 24,956 | Seiler & Holt, | 1 | 2,090 |
| T. H. Schollenberger, | 1 | | 24,153 | C. Schwartz, | 1 | 2,199 |
| Wm. Levan, | 1 | | 24,035 | Edward Pugh, | 1 | 2,001 |
| O. F. Moore, | 1 | | 23,023 | John Odgers, | 1 | 996 |
| Connor & Patterson, | 1 | | 22,838 | Sundry Shippers, | | 13,1 |
| S. Sillyman, | 1 | | 22,626 | 104 Operators, | 144 Col's, | T. 3,396,080 |

The above table exhibits the following:

| | Tons. |
|---|---|
| Seven firms shipped nearly one third of the supply,..... | 1,072,092 |
| Twenty-five firms shipped nearly two thirds of the supply,..... | 2,222,707 |
| Thirty-six firms out of 104 operators shipped the whole supply except..... | 787,088 |

The above is strongly suggestive of the course the operators ought to pursue here. If twenty-five firms shipped two thirds of the coal sent to market in 1855, we cannot see any good reason why a coal association could not be organized in Schuylkill County among the operators, that would be sufficient to protect their interests effectually from associations formed abroad. In consequence of the suicidal course pursued by many of the operators last season, it will require great prudence on the part of the operators to maintain prices at fair remunerating rates during the ensuing season—and by all means they ought to counsel among themselves, and be prepared to start right at the opening of navigation in the spring.

### LATERAL RAILROADS.

Official quantity of coal transported over the different railroads in Schuylkill County for 1855, together with their increase, &c.

| | 1855. | *Inc.* | *Dec.* |
|---|---|---|---|
| Mine Hill and S. Haven, | 1,516,952 | 289,147 | |
| Mill Creek, | 615,854 | 129,282 | |
| Schuylkill Valley, | 549,788 | 6,927 | |
| Little Schuylkill, | 426,208 | | 17,916 |
| Mount Carbon, | 189,738 | 412 | |
| Swatara, | 56,191 | 3,129 | |
| Lorberry Creek, | 47,518 | 9,117 | |
| Tons, | 3,382,935 | | |
| Mount Carbon and Port Carbon, | 769,954 | 111,876 | |
| Union Canal Railroad, | 112,218 | 20,751 | |

The coal transported over the Mount Carbon and Port Carbon Railroad, was received from the Schuylkill Valley and Mill Creek Railroads—and the coal transported over the Union Canal Railroad, was received from the Swatara and Lorberry Creek Railroads. The tonnage, it will be observed, was increased on all the lateral roads in 1855, except the Little Schuylkill, where there has been a slight decrease.

### LITTLE SCHUYLKILL COAL TRADE.

The quantity of coal shipped from this portion of the region in 1855, was mined by the following persons:

| | Tons. |
|---|---|
| J. & R. Carter, | 105,568 |
| Jones & Cole, | 75,643 |
| R. Ratcliffe & Co., | 57,445 |
| Heaton & Carter, | 50,882 |
| Wm. Donaldson, | 50,374 |
| Peter Bowman, | 33,325 |
| Geo. Wiggan & Son, | 28,985 |
| Wm. Levan, | 24,035 |
| Total in 1855, | 426,208 |

Supply in 1854, 444,184 tons. The improvements in this region are noticed in another page.

### SHAMOKIN COAL TRADE—1855.

Below we give all the shipments from the Shamokin Region, that were returned in time for publication:

| | 1854. | 1855. |
|---|---|---|
| Cochran, Peale & Co., | 19,640 | 33,207 |
| J. B. Douty, | | 10,000 |
| Black & Sheaff, | | 10,000 |
| Coal Ridge Imp. Co., | | 12,82 |
| D. Ayers & Co., | 250 | 10,000 |
| Ammerman, Zerne & Wetzel, | | 5,946 |

LORBERRY CREEK COAL TRADE.

The trade from this region has increased to some extent this year. The following persons shipped coal in 1855:

| | Tons. |
|---|---|
| Kitzmiller & Stees, | 21,615 |
| Wheeler & Miller, | 20,208 |
| Eckert, Molley & Newcomer, | 4,789 |
| Molley, Sailor & Co., | 557 |
| Netherwood & Co., | 350 |
| Total in 1855, | 47,518 |

In 1854 the supply was 38,401 tons.

Of the 112,213 tons of coal which passed over the Union Railroad at Pinegrove, 43,780 tons were shipped over the Union Canal, to market.

SHIPMENTS FROM PORT RICHMOND.

The Miner's Journal publishes the following table, showing where the coal from Schuylkill County goes to. By this statement it will be observed that the five New England manufacturing States took more than one half the coal shipped from Richmond in the year 1855.

| | | | |
|---|---|---|---|
| Massachusetts, | 58,074 | Delaware, | 7,769 |
| Rhode Island, | 98,090 | Georgia, | 4,023 |
| Connecticut, | 69,796 | California, | 3,517 |
| Maine, | 38,528 | North Carolina, | 5,113 |
| New Hampshire, | 15,518 | Florida, | 2,312 |
| New York, | 523,813 | New Orleans, | 3,294 |
| New Jersey, | 52,850 | Alabama, | 2,125 |
| Virginia, | 22,721 | Exported to Cuba, Nicaragua, Jamaica, Montevideo, Rio, San Juan, St. Johns, St. Michaels and Thomaston, | 17,232 |
| South Carolina, Charleston, | 20,558 | | |
| Dist. of Columbia, Washington and Georgetown, | 16,754 | | |
| Baltimore, | 10,645 | | |

THE TRADE OF THE LINE.

We give below the trade of the Line, between this region and Philadelphia, which continues on the increase in proportion to the increased shipments.

| | Railroad. | Canal. | Total. |
|---|---|---|---|
| 1850 ..... | 166,992 | 40,871 | 207,836 |
| 1851 ..... | 190,670 | 112,697 | 312,836 |
| 1852 ..... | 189,661 | 132,550 | 322 211 |
| 1853 ..... | 238,328 | 155,750 | 394,078 |
| 1854 ..... | 283,212 | 160,949 | 444,160 |
| 1855 ..... | 294,385 | 187,476 | 481,861 |

Of the above supply, 345,269 tons were delivered at the following seven points on the line, where there are Iron works.

| | Railroad. | Canal. | Total. |
|---|---|---|---|
| Leesport ..... | | 15,888 | 15,888 |
| Reading ..... | 77,861 | 42,111 | 119,472 |
| Birdsboro ..... | 706 | 18,081 | 18,787 |
| Phœnixville ..... | 57,652 | 16,385 | 74,037 |
| Norristown ..... | 26,255 | 23,492 | 49,747 |
| Conshehocken ..... | 37,349 | 1,082 | 38,430 |
| Spring Mill .... ... | 152 | 23761 | 23,913 |
| | | | 345,269 |

It is rather singular that the railroad should furnish more coal to Norristown and Conshehocken, than the canal, which runs through those towns, while the railroad runs on the opposite side of the Schuylkill.

ASHLAND COAL TRADE.

We last year chronicled a shipment of 17 tons of coal from this region, principally samples. We then stated, that if the shipments were *small*, the operators were *big* in faith. We give below the shipments for the last season, which shows that their faith was well founded in their coal beds—and they only want transporting facilities, to double the business the present year:

| | Tons. |
|---|---|
| John Bancroft ..... | 33,169 |
| Gideon, Bast & Co. ..... | 28,078 |
| George S. Repplier ..... | 27,788 |
| Connor & Patterson ..... | 22,887 |
| E. Hammer & Co. ..... | 7,952 |
| L. P. Brooke & Co. ..... | 5,573 |
| N. W. Atkins ..... | 56 |
| Total tons in 1855 ..... | 125,492 |

Sent in 1854, 17 tons. Increase in 1855, 125,475 tons.

LEHIGH COAL TRADE FOR 1855.

The coal sent to market from this region in 1855, was produced from the following named places and collieries. We also give the amount of coal produced in 1854:

| | 1854. Tons. | 1855. Tons. |
|---|---|---|
| Summit Mines (Lehigh proper), | 413,049 | 312,354 |
| Room Run, | 92,188 | 79,855 |
| East Lehigh, | 10,781 | 35,190 |
| | 515,918 | 427,399 |
| Beaver M'w (McClintock & McKnight), | 54,206 | 38,558 |
| Spring Mountain (Wm. Milnes), | 147,745 | 179,220 |
| Colerain (Ratcliff & Johnson), | 85,347 | 97,125 |
| Stafford Coal, | | 10,309 |
| E. Sug. Loaf (Packer, Carter & Co.), | 60,623 | 51,452 |
| N. Y. & Lehigh (Taggart & Son), | 15,422 | 38,855 |
| German Penna. Coal Co., | 4,022 | 4,294 |
| French American Coal Co., | | 7,464 |
| A. Lathrop (Pea Coal), | 694 | 2,845 |
| Beaver Meadow Pea Coal, | | 604 |
| Hazleton Coal Co. (A. Pardee & Co.), | 144,216 | 160,197 |
| Cranberry Coal, do. do. | 68,899 | 84,550 |
| Council Ridge (Sharpe & Co.), | | 1,737 |
| Diamond Mines (A. Pardee & Co.), | 43,481 | 35,454 |
| Buck Mountain Co., | 66,617 | 86,079 |
| Wyoming Region, | 39,232 | 50,209 |
| | 1,246,418 | 1,275,051 |
| By Lehigh Valley Railroad, | | 9,063 |
| | | 1,284,114 |
| | | 1,240,118 |
| Increase in 1855, | | 37,696 |

The improvements in this region, and its probable business this year, are noticed elsewhere.

*By Lehigh Valley Railroad.*

| | Tons. |
|---|---|
| Packer, Carter & Co., | 6,402 |
| W. Milnes & Co., | 2,661 |
| Total, | 9,063 |

All of which was distributed between Mauch Chunk and Elizabethport and Newark.

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COAL TRADE OF WESTERN PENNSYLVANIA.

The Pittsburg Gazette says:—During the year 1855 the Monongahela Navigation Company brought down 22,234,009 bushels bituminous coal. Of this amount, 16,300,159 bushels were loaded in boats for exportation below, and 5,933,850 bushels in flats for city use, manufactories and steamboats. During the same time, 5,175,196 bushels were loaded in barges below the dams on the Monongahela, and shipped below; the total shipment by river for the year 21,475,355 bushels. Estimating a ton at 25 bushels, the exportation by river would be 858,214 tons.

The supply to manufactories and for city use from other sources than the Monongahela River is estimated to be equal to the amount above stated as delivered here in flats, making the total consumed here in manufacturing, on steamboats, and for domestic uses, 10,350,392 bushels.

The amount shipped by canal to Philadelphia and the East, was 13,485 tons; by Pennsylvania road, 50,904 tons; by Erie Extension, to Erie, 140,211 tons; and by Ohio and Pennsylvania Railroad to Cleveland, from Darlington mines, 46,800 tons. The tonnage from all sources will therefore be as follows:

| | |
|---|---|
| By river to ports below | 858,214 tons. |
| By canal to the east, | 13,485 " |
| By Railroad to the east, | 50,904 " |
| By Railroad to Cleveland, | 36,800 " |
| By canal to Erie, | 140,211 " |
| Total shipment, | 1,109,614 " |
| Add for manufacturing purposes, &c., | 414,014 " |
| Total sent to market, | 1,523,628 " |

Reduced to bushels this would give us a total of 38,190,700; and it is probable that there are other sources of supply, from which it is impossible to get details, which would swell this to 40.000,000 bushels.

Estimated according to its value at the point of exportation, the coal sent to market, as above enumerated, was worth $4,904,535; but when estimated by the probable amount obtained for it, its value may be set down at $3,270,852.

The coal trade of Western Pennsylvania is steadily increasing. The increased shipments by river amount to 3,000,000 bushels, and there is a proportionate increase by canal and railroad. The exports in 1854 were considerably less than a million bushels, the estimate for that year being 940,556 tons.

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### COAL TRADE OF BALTIMORE.

*Receipts of Coal at Baltimore, for the past eleven years, to the 31st of December.*

| | CUMBERLAND. | ANTHRACITE. |
|---|---|---|
| 1845, | 16,000 tons. | 90,000 tons. |
| 1846, | 18,393 " | 100,000 " |
| 1847, | 50,259 " | 110,000 " |
| 1848, | 60,280 " | 125,000 " |
| 1849, | 71,699 " | 140,000 " |
| 1850, | 146,645 " | 160,000 " |
| 1851, | 163,855 " | 200,000 " |
| 1852, | 256,000 " | 125,000 " |
| 1853, | 406,000 " | 188,000 " |
| 1854, | 472,258 " | 288,740 " |
| 1855, | 394,442 " | 263,747 " |

The supply of Cumberland coal in the Baltimore market has fallen off during the year 77,816 tons, while that of Anthracite has increased 25,007 tons. The Baltimore American states that the prices of Cumberland opened in 1855 at $4 per ton for fine, $4,25 for run of mine, and $4,75 for lump, cash or interest added. In April they were fixed at $3,50 per ton for fine, $3,75 for run of mine, and $4,25 for lump, at which they continued for the balance of the year. There were shipped to foreign ports from Baltimore 9,989 tons, but the bulk was shipped to the Eastern States. Of the Anthracite 215,921 tons were received via. the Susquehanna and Tide Water Canals, and 47,826 by the Northern Central Railroad.

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### BOSTON COAL TRADE.

The imports of coal the past year have been as follows:

| | FOREIGN. | | DOMESTIC. | |
|---|---|---|---|---|
| *From* | *tons.* | *chals.* | *tons.* | *bush.* |
| Great Britain, | 8,778, | 100 | | |
| Provinces, | | 51,548 | | |
| Philadelphia, | | | 307,807 | |
| Alexandria, | | | 21,999 | |
| Baltimore, | | | 44,563 | |
| Other places, | | | 12,590 | |
| Total, 1855, | 8,778 | 51,648 | 387,259 | |
| 1854, | 12,744 | 43,371 | 378,601 | |
| 1853, | 5,242 | 46,068 | 362,006 | 4,600 |
| 1852, | 9,343 | 40,764 | 431,270 | 14,060 |
| 1851, | 8,457 | 30,330 | 364,078 | 80,880 |
| 1850, | 6,251 | 32,486 | 289,571 | 52,375 |
| 1849, | 12,062 | 34,531 | 261,298 | 20,600 |
| 1848, | 5,795 | 41,308 | 275,246 | 48,600 |
| 1847, | 4,251 | 47,098 | 261,259 | 127,525 |
| 1846, | 5,288 | 21,127 | 187,028 | 151,900 |

The anthracite trade of Boston, in 1855, shows an increase of only 18,658 tons, in anthracite, and only about 5,000 in foreign coal, notwithstanding the Reciprocity Treaty. The increase from the Provinces is only about 8,000 chaldrons.

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COAL COMPANIES LATELY FORMED IN LUZERNE CO., PENN.

| NAMES. | ORGANIZED. | CAPITAL. |
|---|---|---|
| North Penna. Coal Co., | April, 1854, | $500,000 |
| Pittston Coal Co. | May, 1854, | 500,000 |
| Northampton Coal Co., | July, 1854, | 400,000 |
| West Pittston Coal Co., | Sept., 1854, | 500,000 |
| Susquehanna Coal Co., | Sept., 1854, | 500,000 |
| Scranton Coal Co., | Sept., 1854, | 150,000 |
| North Branch Coal Co., | March, 1855, | 250,000 |
| Dock Coal Co., | Feb., 1855, | 300,000 |
| Geneva Coal Co, | April, 1855, | 50,000 |
| N. Y. & Scranton Coal Co., | April, 1855, | 350,000 |
| Mill Creek Coal Co., | April, 1855. | 500,000 |
| Hanover Coal Co., | July, 1855, | 400,000 |
| Penna. Anthracite Co., | July, 1855, | 500,000 |
| Empire Coal Co., | July, 1855, | 500,000 |
| Hyde Park Coal Co., | July, 1855, | 500,000 |
| Hartford Coal Co., | July, 1855, | 500,000 |
| Maryland Anthracite Co., | Aug., 1855, | 300,000 |
| Spring Brook Coal Co., | Aug., 1855, | 500,000 |
| N. Y. & Pittston Coal Co., | Aug., 1855, | 500,000 |
| N. York & Penna. Coal Co., | Sept., 1855, | 500,000 |
| Luzerne Coal Co., | Oct., 1855, | 225,000 |
| Fellows Coal Co., | Oct., 1855, | 250,000 |
| Luzerne Anthracite, | Oct., 1855, | 75,000 |

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ANTHRACITE COAL TRADE, AS COMPARED WITH THE CENSUS OF THE UNITED STATES.

The following interesting table from a report of P. W. Sheafer, Esq., exhibits the progress of the Anthracite Coal Trade as compared with the increase of the population of the United States. It shows at a glance the rate of increase up to 1850, and is a pretty safe basis upon which to calculate the probable future increase.

The trade of 1850 was only 3,358,899 tons, and in 1855 it was increased to 6,635,789, and should it increase in the same ratio, doubling itself nearly every five years, we may safely calculate on 10,000,000 as the lowest possible figure for 1860.

*Increase of the Coal Trade and population of the United States.*

| | *Population.* | *Anth'e Coal Trade.* | *Rate of Inc.* |
|---|---|---|---|
| 1830, | 12,866,020 | 174,784 | 78.6 |
| 1840, | 17,069,453 | 865 414 | 19.4 |
| 1850, | 23,191,876 | 3,358,899 | 6.9 |
| 1860, | *31,710,872 | 10,000,000 | 3.0 |

* As estimated by DeBow. See Census U. S.

WEST PITTSTON COAL CO.

This company of which Edward C. Knight is president, has an office in Philadelphia, and their mines are in Luzerne Co. Penn., nearly opposite the wide gap of the mountain, where the river enters the valley, and opposite the town of Pittston. Their lands embrace nearly seven hundred acres of well improved farms. The ten workable veins of the Wyoming Valley are estimated to yield on this tract 50,000 tons per acre, by the report of Mr. P. W. Sheafer. These mines are directly opposite those of the Pennsylvania Coal Co. The veins are nearly horizontal, of compact, solid coal—containing little or no sulphur, face burning white ash, scarcely any clinker, and free from smoke.—The Eastern, Northern, and Southern markets are all accessible from this locality.

The following are the results of a practical analysis of the coal by Prof. J. C. Booth.

| | |
|---|---|
| Volatile matter, . . . . . | 5.50 |
| Fixed Carbon, . . . . . | 89.65 |
| Ash (white,) . . . . . | 4.85 |

Its composition, therefore, corresponds with that of the best kinds of Anthracite.

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CUMBERLAND COAL TRADE for 1855.

The increase of shipments from the Cumberland region for 1855 over 1854 was 16,005 tons. The increase in 1854 over 1853 was 114,320 tons. The reasons assigned for this decrease are generally of a temporary nature. They are thus stated:

At the beginning of the year 1855, it was confidently predicted that the shipments from existing collieries, and those which were to have commenced operations early in the ensuing season, would amount to not less than one million tons. This conclusion seemed based upon fair grounds. The ratio of increase for several preceding years was taken as the basis of the calculation, and justified the conclusion arrived at. But experience has proven them fallacious. The maximum demand appears to have been arrived at in 1854; and notwithstanding the extraordinary exertions of 1855, and they far exceeded those of the preceding year, the increase, as shown by our annual statment of mining operations, was only about sixteen thousand tons, but little exceeding the one half of what could have been accomplished in one week, if the demand had justified operators in working their collieries up to one-fourth of their productive capacity. It is true, many obstacles intervened to prevent a more extended business. To many of those we have already alluded. There is another, however, which may be mentioned, and it constitutes, perhaps, the main cause of the small increase. We refer to the difficulty in inducing consumers of coal to change their furnaces, grates, &c., and adapting them to the Semi-Bituminous coal of this region. Getting the start of us many years in the market, and consumers becoming familiar with its use, the Anthracite coal was very hard to supersede. Besides the expense consequent upon the change adverted to, the Anthracite, by reason of the proximity to market, and the advantages enjoyed by it from a much lower tariff of rates for transportation, was enabled to enter the market and be disposed of by operators at a much lower figure. It is true that encroachments were from time to time made upon it by the Maryland coal, and these have been steadily held, the consumers expressing much satisfaction at its very decided superiority for smithing, manufacturing, and marine purposes. But still, the demand has not realized the anticipations of operators, formed at the commencement of 1855, and the experience thus acquired will prove the imperative necessity of ma-

king more vigorous exertions, and of holding out to consumers still greater inducements in future. By this means alone can the trade of 1856 be materially augmented, unless, indeed, the condition of matters generally should undergo some very favorable transformations.

The trade of 1856 has thus far been moderately active, considering the tremendous snow storms with which this region has been visited. Some heavy orders have been received. The George's Creek Coal and Iron Company has contracted to supply the Baltimore and Ohio Railroad; the American Coal Company has been favored with several large orders, and expects to throw into market during the year not less than two hundred thousand tons. Other operators have entered into contracts, and we may anticipate for the early part of the season, at least, considerable activity in the coal business. But without offering the inducements hinted at, there is reason to conclude that the increase will not be very great. The great endeavor should be to compete successfully with other coals, and efforts to this end should be made.

The following table exhibits the amount shipped from the region since the commencement of the trade in 1842.

| YEARS. | Jennings' Run Valley. TONS. | Bradford's Run Valley. TONS. | Western port. TONS. | Total. TONS. |
|---|---|---|---|---|
| 1842 | 757 | 951 | | 1,708 |
| 1843 | 3,661 | 6,421 | | 10,082 |
| 1844 | 5,156 | 9,734 | | 14,890 |
| 1845 | 13,738 | 10,915 | | 24,653 |
| 1846 | 11,240 | 18,555 | | 29,795 |
| 1847 | 20,615 | 32,325 | | 52,940 |
| 1848 | 36,571 | 43,000 | | 79,511 |
| 1849 | 63,676 | 78,773 | | 142,449 |
| 1850 | 76,950 | 119,898 | | 196,848 |
| 1851 | 122,331 | 135,348 | | 257,679 |
| 1852 | 174,891 | 159,287 | | 334,178 |
| 1853 | 234,441 | 225,813 | 73,725 | 533,979 |
| 1854 | 203,343 | 263,115 | 181,840 | 648,299 |
| 1855 | 170,685 | 200,634 | 292,995 | 664,304 |
| | 1,138,004 | 1,304,810 | 548,560 | 2,991,374 |

AMERICAN COAL COMPANY.

The directors of the American Coal Company of Allegany county, Maryland, present their first annual report to its stockholders. They report that from the 12th of January, 1855, the date of commencing operations, to the 30th of November last, they have mined 95,352 tons of coal, of which 57,067 are from the Caledonia estate, and the remainder from the Jackson. Of this quantity they have sold 88,313 tons, besides 864 tons of coke, out of 559 made.

| | |
|---|---|
| The receipts for the year are . . . . . | $301,766 19 |
| Expenses, . . . . . | 283,057 53 |
| Leaving for profit, . . . . . | $18,708 66 |

The trustees report that they have received $371,626 49 out of 499,750 subscribed for 59,970 shares, and that they have paid off liens and encumbrances amounting to $253,392, which the estates they bought were subject to, and that with the means now on hand, and the proceeds of the stock yet to be received, they will be able to discharge every encumbrance upon the lands within the year now current.

They own 1,481 acres of thick vein coal, and 1,000 of smaller veins. The thick veins will yield 15,000 tons per acre. The thick veined lands extend three miles along the George's Creek railroad, and are accessible by means of single inclined planes, at an average distance of six and a half miles from

Piedmont, the point of junction with the Baltimore and Ohio Railroad. The working capacity of the two openings now in operation is about 1,000 tons per day.

The Baltimore and Ohio Railroad Company have been large buyers of the coal of this company for the use of their freight engines. Experiments, it appears, are daily extending the use of coal instead of wood, as a more economical motive for railroads; and in the form of coke, it has been found perfectly adapted for locomotives. The New Jersey Railroad Company have used the coke of the American Coal Company, and report a saving of nearly fifty per cent. from substituting it for wood. They purchased a cargo for the purpose, and the railroad superintendent reports favorably of it.

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### WYOMING COAL TRADE FOR 1855.

Below we give the shipments from the Wyoming region, as far as they have been returned to us by the shippers.

| | Tons. | | Tons. |
|---|---|---|---|
| Penna. Coal C., | 526,500 | D. Blanchard, | 20,000 |
| Baltimore Coal Co., | 75,000 | Boukley & Leyshon, | 20,000 |
| Wilkesbarre Coal Co., | 52,000 | Susquehanna & Erie Coal Co., | 20,000 |
| Philadelphia Coal Co., | 40,000 | Freeland & DeWitt, | 20,000 |
| A. Price, | 40,000 | David Morgan, | 20,000 |
| Tompkins, Price & Co., | 30,000 | James Freeland, | 15,000 |
| Geneva Coal Co., | 30,000 | John Shonk & Turner, | 9,800 |
| Black Diamond Colliery, | 30,000 | Gaylord & Reynolds, | 7,000 |
| Harding & Co., | 30,000 | Mill Creek Coal Co., | 7,250 |
| Maryland Coal Co., | 25,000 | Thomas Wren & Co., | 2,446 |
| Mordecai Diamond Colliery, | 25,352 | | |

From the following firms we received no returns; we hope, however, each one will forward the amount shipped by them, immediately, for insertion in our Coal Almanac for 1856.

| | |
|---|---|
| Lee, Penn & Co., | David Levi, |
| Jamieson Harney, | H. B. Hillman, |
| W. W. Lance, | Pittston Coal Co., |
| William Patten & Co., | E. C. Wadham. |

S. Bonnell, jr., & Co., of the Black Diamond Colliery, have sold their mines and land to the Baltimore Coal Co., adjoining their lands.

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### ADVICE AND PRACTICAL HINTS TO UNDERGROUND COLLIERY MANAGERS.

[Concluded from page 365.—Vol. V.]

There will probably be many young men in your mine who may shortly become coal getters;—you may train the young more easily than you can correct the bad practices of the old, and if you neglect to adopt a proper course of training in regard to these young men, and they grow up indifferent workmen, you will incur a grave responsibility. No young man should be allowed to get coal unless he will undermine low.

The floor of the seam will, in some cases, be favorable to undermine in. A tender floor, or a floor mixed with bands of coal, may, under some circumstances, be undermined in, without cutting good coal too small. There are some objections to undermining in the floor of the seam, as it destroys the smooth surface, and makes a bad bottom to shovel upon, unless you have a hard even surface for the bottom of your undermining, which will then make a good surface to work upon. The screenings, or slack, from seams which are undermined in a bad floor, will be almost useless, owing to the quantity of thill or floor which is intermixed with it. If the coal is separated below, and the small be cast away, some portions of the floor will go with it, but much will come out with the coal. If the loss of the slack, and the increased cost of getting the coal by casting away the small, and undermining in the floor, is more than compensated for by the increased quantity of round coal, you may undermine below the coal when the floor is favorable and dry; but care

should be taken that you possess these advantages before you commence undermining in the floor.

Another point to which I wish to direct your attention is the blasting of coal. This is generally done very injudiciously—too much powder is used for a shot, which impairs the cohesion of the coal; and, in many cases, the hole is not drilled in the proper part of the seam.

The hole for blasting is generally drilled near the roof, thus making the line of least resistance, in thick seams, to the effects of the powder in the direction of the hole, and requiring a much larger charge of powder to sever the coal from the bed, than if the hole were in the most favorable position.

In order to blast coal with less injury to its cohesion, the hole for receiving the poweer should be in such a position, that the line of least resistance may be in the direction of the line, or from the hole to the undermining, when a much smaller charge will be required to sever the coal from the bed. You should ascertain by experiments under your direction, the best position for the hole in the seams which require powder, and also the least quantity that will sever the coal from the bed in the largest pieces. Where the coal separates freely from the roof, the position of the hole should be as shown in section 2; where the coal adheres to the roof, the position of the hole should be as shown in section 1. The quantity of powder required, and the position of the hole, should never be left to the pit man's judgment.

When you can dispense with powder in getting coal, do so by all means, and make more use of the hammer and wedge, as the coal will then be sent to market in a much better state.

You should take care that each coal getter is at all times provided with a full set of tools, whether it is the practice for the master or the pit man to find them; for, without a proper set, even a good workman cannot send his coal out in a good state.

I would here make a few remarks on the objectionable practice, in many collieries, of each collier providing labor to convey his coal to the horse-roads or shafts. When contracts of this nature are made, the youths employed in removing the coal, are, to some extent, freed from the authority of the Underground Managers, and look upon the collier as their master, who too often encourages them in acts of disobedience. If a collier cannot get as much coal in a day as a youth can remove, such a rate has to be paid for the coal as will make wages for both, and the youth's spare time is frequently employed at the cold face, which he almost invariably cuts too small.

If the getting and conveying coal were separated, and each were paid for by the score, dozen, or ton, as the case might be, the coal would be conveyed at a less cost, as the youth's time would be entirely occupied with his own duties, and he would convey a greater quantity in a given time; he would, moreover, be under the control of the Underground Managers, and as opportunity offered, might be placed in those parts of the mine most favorable for training him as a pit man. Managers accustomed to the former practice, effecting this change, will shortly find their labor diminished, and that better order can be maintained in the mine.

It is customary at many collieries to determine by lot, every two or three months, in which part of the mine, each collier shall work; thus, all the pit men are placed on the same footing with regard to the choice of places, and the unpleasantness and jealousy which frequently exist amongst them, where it is the practice for the Underground Manager to decide where they shall work, are avoided.

On account of the numerous strikes which have taken place amongst pit men, and the rapid extension of mining operations during the last few years, many workmen ignorant of mining have been employed in mines, and to this circumstance may be attributed the great proportion of slovenly and incompetent pit men now to be found in almost all collieries. Especial care should be bestowed upon these men in regard to instructing them in their duties, and informing them of the dangers incident to mining.

It is your duty to protect and promote your master's interest, and not to allow it to be sacrificed by the negligence or indifferent workmanship of those under your care. Never employ slovenly workmen, but select, if possible, good, steady, and intelligent men. I would particularly draw your attention to the small proportion of good pit men, or coal getters, to be met with in almost all collieries, and I would urge you to use your best exertions in improving the standard of labor among your pit men. Much will depend on your diligence in this respect. By good pit men, I mean those who undermine the coal low, and send to bank as great a proportion of large or round coal as the seam will yield, and attend regularly to their work.

I am aware that you will meet with much opposition from pit men, in endeavoring to carry these recommendations into effect, because they generally take erroneous views of things which interfere with their labor, or cause an alteration in the state of things to which they have been long accustomed. In all cases I would advise you to be guided rather by your own opinion as to what is necessary to be enforced, than to be influenced by the inconsiderate ideas of the men in your employ.

*Rules and Regulations to be observed by the workmen at —— Colliery.*

It is impossible, within reasonable limits, to frame Rules for the working discipline of a mine, that may be applicable to all collieries, as there will be circumstances connected with some collieries requiring special rules. The following are rules that I have had in force at a fiery collery, a great proportion of which are inapplicable to a mine producing no gas.

*Rules for Surface Laborers.*—The banksman must be in attendnace every morning during the descent of the workmen, and remain at his post until the last man is out of the pit at night. Before any person descends in the morning, the ropes must be run up and down in the shafts, and carefully examined by the Banksman, from the cages to the ends fastened on the drums or verticles. The Banksman must also daily examine the cages, chains, pulleys, and other machinery about the pit top, and if he discover any flaw or breakage, he must see that it be repaired before any person is allowed to descend. The Banksman must also keep an account of the name of each workman who descends and ascends without working a full day: and must not allow any person unconnected with the colliery to descend without orders; and further, must not permit any person whatever, in a state of intoxication, to descend. If the Banksman act contrarily to these rules, he will be fined ——, or be immediately discharged.

Any workman obstructing the Banksman in the execution of the above orders, or interfering with his duties, will be fined ——, or be immediately discharged.

The Engineman must examine his engine daily, and see that the drums or verticles, ropes, and every part of the machinery, are in good repair: if any flaw or breakage is discovered, he must see that the damage be made good before any person descends. The Engineman must not allow any person to work his engine during the time the pit is working, or persons are descending or ascending, nor allow any person to learn engine driving, without the consent of the Viewer. He must use great care when persons are descending or ascending, and only drive the engine at half the usual speed for drawing coal. He must, as far as he is able, assist the Banksman in enforcing his orders. If the Engineman is found acting contrarily to these orders, he will be fined ——, or be immediately dismissed.

All Laboring men must be at work by —— o'clock in the morning, and remain until — o'clock at night, except on Saturday, when they must leave off work at — o'clock, and on *Pay* Saturday at — o'clock, half an hour being allowed for breakfast, and one hour for dinner each day.

The workmen must take care of the tools entrusted to them; but should they destroy or lose any of them through carelessness, they must make such *good.*

A fortnight's notice is to be given or received by each workman previously to leaving his employment, or before any alteration is made in the rate of wages; and, after such notice is given, wages will not be considered due until the time specified in the notice has expired.

*Rules for Underground Laborers.*—The Underground Manager, and qualified aisistants appointed with the consent of the Viewer, must go round each pit, and examine the state of each workman's place with the safety lamp, before the workmen go to their places. Any workman found going into his place before it has been examined, will be fined —, or be immediately discharged.

If a workman's place, or any part of the mine, is found dangerous from fire damp, choke damp, bad proof, or other cause, a signal, which must be known to all the workmen, must be left a safe distance from the seat of danger, and any workman passing beyond this signal, will be fined —, or be immediately discharged. And further, any workman going to any part of the mine except his working place, or on the proper road to his work, without orders, or a sufficient reason, will be fined —, or be immediately discharged.

Before any person descends or ascends any of the shafts, the proper signal must be given; and all signals from the shafts must be given in the Engine house near the Engineman, by apparatus for that purpose, in order that the necessity for the Banksman to call to the Engineman may be avoided; and any workman descending or ascending, or any Banksman or Hanger-on allowing any workman to descend or ascend, when the pit is at work, without the usual signal being given, will be fined.

Not more than —— persons must descend or ascend the shafts at once, nor against tubs full or empty in the cage; and any person acting contrarily to these orders will be fined ——.

The Viewer or Underground Manager will determine in which part of the mine safety lamps must be used. Any person using a naked light, where safety lamps have been ordered to be used, or found with his lamp top off, or leaving a light in the mine, will be fined ——, or be taken before the Magistrates for the offence.

The stoppings, crossings, and doors, must be daily examined, and all bratticing kept in good repair, and be not less than seven feet back from the face of the place; and all air-doors to direct the ventilation must be so hung that they will shut of themselves. Any person interfering with any air-door, except passing through it, or attempting to derange the ventilation in any way, will be taken before the Magistrates for the offence, or be fined ——.

The air-courses, and the state of the return air, must be examined daily, and if the return is found highly charged with fire damp, it must be sent into the upcast without passing over the furnace, or, if sent over the furnace, it must be diluted with a scale of fresh air.

The openings in the main-roads must be made good with stoppings, one brick in length, set in lime; and, when practicable, in addition to the brick stopping, the openings must be packed solid with stone or other material, so as to resist a blast in case of an explosion.

Sufficient timber must be set to support the roof in every working part of the mine, and no props must be drawn in the pillar workings without a safety lamp. Particular attention must be paid to the state of the roof, and its temporary supports, when any considerable reduction takes place in the pressure of the atmosphere, as there is greater liability in the roof to fall at such a time.

When working the pillars, large falls of roof must be carefully watched, particularly the first falls which take place after the pillars are commenced working, and also the falls in the banks of long work, for both of which preparation must be made by an increased circulation of air, and by securing the working face with timber or other supports. In mines producing gas, large quantities are generally forced from the goaf. The workmen are desired, in all cases, immediately to inform the Underground Manager, or the person in authority under him, of any danger that they may observe in the mine.

The Underground Manager, and those in authority under him, must bear in mind that atmospheric changes influence the discharge of bodies of gas from the goaf. The Barometer indicates these changes in the atmosphere. In the absence of a Barometer they should observe, daily, the point from which the winds blows, as changes takes place in the atmosphere with changes in the wind. (For particulars on this subject, see Chapters 17 and 19.)

Any person found smoking in the mine, will be fined ——, or be taken before the Magistrates for the offence; and any person found with lucifer matches or a pipe in his possession, will be fined ——.

The Colliers must work the coal to the best advantage, and send as large a portion of round or large coal as the seam will yield, and the coal must, in all cases, be sent out clean from slates and stones, and well riddled. Any tub containing —— of stone or other refuse, or not being well riddled, or being sent to bank short measure, will be deducted from the workman's wages, if such tub is sent out after notice has been given; and any tub of round, sent to bank reared or set, will be deducted without notice. The workmen must get the different seams according to the directions and dimensions given by the Viewer, or Underground Manager, and if the workmen do not conform to the directions given, they will have to make good all damage arising from the neglect or disobedience of orders. No wages will be considered due until such damage is either repaired or paid for.

Any Collier, after he has descended the pit, not working a full day's work, nor sending out such a quantity as may be considered a fair day's work of —— hours in the seam in which he works, will be fined ——; and any Putter doing the same will be fined ——. No fine will however be imposed in case of sickness or other excusable circumstances.

No ale or intoxicating drink is allowed to be brought on the colliery, or taken down the pits, except in cases of necessity, and then only by the order of the Manager. Any workman infringing this rule will be liable to be discharged.

One month's notice shall be given or received by each Underground Workman before leaving his employment, or before any alteration is made in the rate of wages; and after such notice is given, no wages shall be considered due until the time specified in the notice has expired.

*Rules for the Safety Lamp.*—No Safety Lamp is to be used without having been first *examined*, *cleaned*, *passed as safe*, *and locked*, by a competent person on the colliery.

If an accident happen to a lamp, or the oil is spilt on the gauze, or the lamp is rendered in any way unsafe, the workman must put out the light by drawing the wick down within the tube with the pricker, and on no account must he blow the light out. He must then carry the lamp to the Lamp Inspector to be exchanged.

Any workman observing the indications of fire damp by the lamp, must carefully move the lamp, and with the picker pull down the wick within the tube. He must then withdraw from that part of the mine, and give information to the person in authority in the mine.

Any person acting contrarily to these orders, or in any way attempting to damage a Safety Lamp, will be fined ——, or be taken before the Magistrates for the offence.

Any person observing any improper treatment of the lamp, is desired to inform the Underground Manager or Lamp Inspector; and any one giving such information will be rewarded.

# IRON AND ZINC.

### RAILROAD BARS MANUFACTURED IN THE UNITED STATES.

The amount of railroad bars manufactured in the United States in 1854, was 133,700 tons. The amount manufactured in Pennsylvania was 74,445 tons.

### IMPORTS OF RAILROAD IRON.

According to the reports of the Treasury Department the importation of railroad iron has been as follows, for the year ending June 30th.

| | | |
|---|---|---|
| 1851 | 188,625 | tons. |
| 1852 | 245,625 | " |
| 1853 | 296,995 | " |
| 1854 | 283,665 | " |
| 1855 | 127,516 | " |
| Total | 1,143,426 | " |

The value of this must have been nearly $37,000,000.

### IMPORTS OF PIG IRON.

The reports of the Treasury Department show the following, for the last six years ending June 30th.

| | | |
|---|---|---|
| 1850 | 74,874 | tons. |
| 1851 | 67,249 | " |
| 1852 | 91,873 | " |
| 1853 | 114,227 | " |
| 1854 | 160,483 | " |
| 1855 | 98,924 | " |
| | | " |
| Total | 507,630 | " |

### THE DEFECTIVE MANUFACTURE OF RAILROAD BARS.

With the introduction of railroads, in the truly national sense of the expression, the attention of numerous scientific and practical men was directed to the deflexion of rail bars under the various pressures to which they were subjected, the object of their inquiries being the discovery of a form which should possess the greatest stiffness, both vertically and laterally, with the smallest consumption of metal.

The fish-bellied rail was, on its invention, considered to possess these properties in a remarkable degree; but from causes which need not here be detailed, the calculations which were formed regarding its stability, were not realized in practice, and it was replaced by others of a parallel form. Wrought rail bars are now rolled of one uniform depth from one end to the other, without reference to their sectional construction. It is to bars of this form, then, that scientific men have directed their attention, by testing in various ways, their capabilities and qualities. The deflexion of rails of different depths and weights when placed on the same bearings under similar loads; the deflexion of a rail at various bearings, with the same weight; and the deflexion of the same rail at fixed bearings, but variously loaded, has been ascertained, by direct experiments conducted by competent engineers, who have recorded their observations in scientific journals in the United States and England. The beneficial effects of the publicity given to their inquiries is beginning to be seen, in the increased depth and weight of the rail bars now making, over those manufactured a few years since, and in the reduction of the dis-

tances between the bearings (where intermediate supports are adopted in preference to the longitudinal system), from the dimensions originally fixed upon as the most proper. By thus increasing the depth and weight of the rail, conjointly wtih a diminution of the distance between its supports, the strength of the rail bar is immensely increased, and the deflexion from a right line on the passage of heavily laden carriages, is exceedingly small on judiciously proportioned roads worked with suitable stock.

Although the proportions of rail bars most conducive to economy in the expenditure of metal and working power, has been ably investigated by scientific men of great attainments, yet, in consequence of the difficulty and expense necessarily atending any extensive experiments on heavy metallic bars, added to the limited acquaintance possessed by such men of the process of manufacturing rail bars, much important information may still be acquired by those possessed of the means and inclination for making further experiments—especially, if their inquiries be directed to the different effects produced on the finished rail bars by departures from the mode of manufacturing usually pursued. The most correct deductions will be attained where the requisite science is combined with an intimate practical acquaintance with the modes of manufacture adopted. Manufacturers, themselves, would, therefore, appear to be the most eligible parties for conducting such investigations; but, a blind adherence to established rules and procedure, is eminently characteristic of rail manufacturers. Rarely endowed with the desire and abilities for elucidating the causes of the phenomena daily witnessed in their factories, and abundantly occupied with the management of their properties, science has secured little assistance or encouragement from beyond the adoption of its principal discoveries, when these have resulted in an immediate diminution of the expenses of manufacturing. As a necessary consequence of this incompetence to deal with subjects requiring scientific research, sufficient attention is not paid to the various effects produced on rail bars by causes which, from their simplicity and apparent insignificance, are too often considered as beneath the notice of practical men, but which are in reality of the greatest importance.

The writer has already noticed the injurious effects produced on rail bars by the employment of various size bars in the same pile, by which seven-eighths of the bars made are rendered less or more unsound, and has described a simple means whereby metal of a fibrous structure may be readily converted into bars of crystalline fracture. It now remains only to notice the extraordinary discrepancies observed in the deflexion of rails of the same pattern and quality when placed on the same blocks, loaded with similar weights for similar periods of time, to show the utter inattention exhibited at iron works to the most essential particulars to be attended to in manufacturing malleable iron rail bars.

The attention of the writer was directed to the subject of deflexion, by observing that bars of reduced section frequently deflected less from a straight line than others of a heavier, and undoubtedly stronger section. And what appears equally strange, the deflexion of bars made in the same manner and within a few minutes of each other, differed very considerably: while one bar deflected 1 inch, another of precisely the same pattern and make, deflected 1.5 inch under similar circumstances. Still greater irregularities have been noticed in the proving machine.

Extraordinary as this irregularity in the deflexion of similar bars under like circumstances may appear, the quantity of permanent deflexion or 'set,' remaining after the removal of the pressure, differed still more widely in the case of different bars. It was ascertained by numerous experiments, that the 'set' taken by some bars was twelve times that taken by others.

It was at first supposed that this difference arose from some variation or irregularity in the mode of piling, and also in the quality of the metal employed. Alterations were therefore made in the piling, and the results noted, but the irregularity of the deflexion was equally great as before. The quality

of the metal was then correctly ascertained, and disposed in the most effective manner for offering the greatest resistance to the compressing and tensile forces, but without success. Attention was next directed to the heating and rolling processes, when it was discovered that the deflexion was slightly affected by the mode in which the heating had been conducted. The primary cause, however, remained undiscovered, and further experiments were required to ascertain the cause of this widely spread, though little known, defect in railroad bars.

In the course of the preceding experiments to discover the defect, by altering the arrangement of the piles and the disposition of the various qualities of metal, it was frequently observed taht the same rail was more elastic when pressed on one side than when pressed on the other, although of that form known as the parallel double-headed rail, with the same quantity and a similar quality of metal in each head. On repeating the experiments and recording the results, it was observed, that in very few of the bars was the strength to resist compression the same from either side. The variation was very great, and after carefully conducted observations, the same difficulty in arriving at a satisfactory solution of the cause was experienced as in the previous experiments, having for their object the discovery of the cause by which different bars possessed different degrees of elasticity. The quality of the metal, and manner of working were found to affect it, but in a degree too inconsiderable to be considered as the acting cause.

The importance of the subject, and the beneficial results aimed at, rendered the inquiry one of no common interest, and, notwithstanding the non-success which had attended the experiments thus far tried, the subject was prosecuted; but instead of confining the inquiry to the quality of the metal, and mode of working, circumstances pointed out the propriety of taking into consideration the form of the bar before passing through the finishing operation, termed 'cold straightening,' and, trifling as it may seem, the longitudinal form of the rail was found to exercise a most important influence on its strength to resist deflexion. Indeed, the great variation in the deflexion of rails when tested under like circumstances, was ultimately discovered to be owing to the form of the rail before cold straightening. If perfectly straight, and the quantity of metal disposed equally, the deflexion on the application of the pressure to each side will be nearly alike; but if it partakes of a curved profile, the deflexion will be unequal, and its elasticity, also, will be greater when on one side than when on the other. From the little attention which has been paid to this department of the manufacture, the greater number of the rails are less or more curved before undergoing the cold straightening process.

In the majority of rails that are made, the bulk of metal in the head is greater than that in any other part, and, in cooling, this mass of metal retains the heat so much longer than the thinner portions of the bar, that it contracts after the other portions have parted with their caloric, and imparts to the upper or wearing side of the bar a concave outline. To counteract this tendency to assume a curved form, the bar is bent over a convex block whilst hot, by which means it becomes curved in an adverse direction; hence the change of form which occurs in cooling tends to produce straightness. The convexity given to the bar when hot, is equal to the concavity which it would assume in cooling from a straight line; theoretically, therefore, it should require no after-straightening, but practically, it is otherwise. The bars when stocked on the rail bank are variously curved, some convex, others concave—very few approaching the desired straightness. This irregularity occurs principally from the different temperatures possessed by the bars when being curved; the convex block having been made to suit the most usual temperature of the bars whenthey arrive at this point of the manufacture, any excess or diminution therefrom will result in a corresponding diminution from a straight line. In the case of parallel double-head rails, the operation of curving is unnecessary, but the unequal rates of expansion and contraction of different

descriptions of metal, not unfrequently cause such bars to deviate cousiderably from a right line.

Of the sufficiency of this agent to cause the irregularity mentioned, there can, on an examination of the subject, be but one opinion. Assuming that the bar before straightening has a concave profile, which is to be brought straight by hammering or pressure, it will be evident that the particles of metal on the concave side must be violently distended, and those on the under or convex side will be compressed, to produce this result. To understand better the effects of this forced straightening, the generally received opinion that wrought iron is elastic, must be abandoned, when it will be conceded that the particles of metal forcibly strained, acting in concert with those compressed, have a direct tendency to restore the bar to its original profile. If, then, this bar be laid on supports or continuous bearings, there will be, in addition to the pressure excited by the load, the direct tendency of the metal in the bar to return to its curve to deflect it from a right line.

On the other hand, if the rail bar had been convex on the upper side and concave on the lower, the effect of straightening it would be lateral compression of the upper fibres conjointly with an elongation of the lower strata of fibres—the reverse, in short, of the above—thus, at one and the same operation, adding to the closeness of the resisting media, and bringing the tensile properties of the lower portion of the bar into a state of permanent tension. The properties of the metal having been brought into full play while the bar is in a quiescent state, the deflexion, on the application of the load, is immediately retarded, and the ultimate descent is also from the same cause greatly diminished from what it would otherwise be. That this view of the matter is correct, we may adduce in its support the well-known fact that the application of a weight on a perfectly straight rail which has received no cold straightening, results in an immediate deflexion from a right line proportionable to the load and length between supports, and this deflexion will increase until the resistance offered by the metal to the further compression of the upper, and distension of the lower parts of the bar, eqnals the weight applied.

The experiments herein alluded to, were made principally on rails of the double-head pattern, weighing about 70 pounds per yard. They were placed on cast iron supports 13 feet 1.5 inches between bearings; at this bearing a weight of 4300 pounds was suspended on the centre of the rail for one minute. With bars straight from the rail bank, the deflexion on the application of this load averaged 1.380 inches. With bars which had a rise or convexity of the upper surface of .5 inch, which was subsequently removed by cold straightening, the descent was 1.181 inches, but with a rise of 1.3 inches, the descent or deflexion on the application of this weight, was .986 inch only. These are the average results from more than 400 bars tested in this manner. They exhibited in the most conclusive manner, that increased strength to resist deflexion may be imparted to the rail by attention to its longitudinal form before being cold straightened.

The inability of the bars to resist deflexion when they had a concave profile, was demonstrated by a few experiments on bars which had a concavity of .5 inch before cold straightening. The application of the load of 4300 pounds, resulted in an immediate deflexion of 1.763 inches, or .383 of an inch more than with bars which had received no cold straightening. With bars having a concavity of more than .5 inch before straightening, it was observed that the deflexion was proportionably greater. The deflexion being 1.380 inches with bars which had not been cold straightened, this dimension added to the quantity of concavity taken out by hammering or other straightening, gave the deflexion of such bars very nearly.

The deflexion which remained after the removal of the load of 4300 pounds, varied with the amount of convexity given to the rail. In those which had been brought out from the rail bank straight, the deflexion or permanent set from a straight line occasioned by this weight, was equal to .102 inch. The bars which had a convexity of .5 inch before straightening, retained a perma-

nent set of .057 inch, but those which had been curved to the extent of 1.3 inches before straightening, retained after the removal of the load a permanent set of .0118 inch only. Rails which had been hammered straight from a concave profile, retained a permanent deflexion much greater than the others. Instances were recorded of such bars retaining a set of .210 after the removal of the load.

During the experiments it was observed, that curving the rail so that it had a convexity of more than 1.3 inches in 13 feet, 1.6 inches was not attended with corresponding advantage. This is the highest curvature that should be attempted in practice with the metal commonly used. If it is exceeded, the permanent strain on the lower fibres of metal produced by the cold straightening appears to weaken the rail. In the course of some experiments, having a different object in view, it was ascertained that the rails usually manufactured for railroad companies, would not bend cold to a less radius than 20 inches without fracture of the outer rim of metal; and when curved of a greater radius, the effect of the curvature was to diminish the strength of the rail to resist fracture from a weight falling freely on it while supported on cast-iron blocks, in a ratio corresponding nearly to the radius to which it had been curved.

In the course of these experiments, one other fact was discovered, having a material influence on the strength of rail bars, which it may be propor here to record. We have already stated, that the deflexion of a straight bar which had received no hammering, after cooling, with a load of 4300 pounds on the centre between supports 13 feet 1.5 inches apart, averaged 1.380 inches, and the permanent set, .102 inch. A number of the rails thus tested were submitted to a repetition of the test after standing one hour unloaded, when it was ascertained that they descended still further; the additional deflexion averaging .039 of an inch, but on the removal of the weight, the permanent set occasioned by this second test, in addition to that caused by the first, amounted on the average to .013 inch only. On a number of bars, the test was repeated a third time, after they had stood 12 hours, with still more striking results. The additional deflexion due to the third testing, averaged .004 inch, and the permanent set .003 inch. These experiments show the importance of bringing the tensile properties of the metal in action before applying the load, if a minimum deflexion is desired. But their application, by causing a departure from a straight line in the finished rail, is inadmissible in practice. It can be done, however, in the manner we have described, viz. by giving the surface of the rail a convex profile while hot, and afterwards bringing it straight by hammering or pressure when cold.

From inattention to this property of iron rail bars, the rails on the majority of the roads constructed have, from the passage of heavy engines and loaded cars, deflected from a straight line, so as to present a concave profile varying in its depression from a right line from one to five-tenths of an inch.

The facts herein detailed are deserving of attention from engineers generally, now that wrought iron is extensively used in various structures. We may cite an instance of its successful application in the construction of an iron building, where wrought iron wall plates, 22 feet long by 7 inches deep, supported at this distance apart by iron pillars, carried the iron couples and slate roof of a building 33 feet span in the clear. The increased stiffness attained by curving rail bars when hot, induced the application of the principle to these wall plates, which were curved 1.75 inches—the convex side being placed uppermost. On the completion of the structure, the wall plates deflected from their previous form until they became nearly straight. Hence, had they been straight when put up, the deflexion of 1.75 inch from a straight line would have produced a convexity in the under side of like amount, and, consequently, disturbed the whole of the framework of the roofing.—*Truran.*

ALBANY IRON WORKS.

In presenting the following sketch of the Albany Iron works, we would precede it by stating that we are now making arrangements to present in the pages of the Magazine very complete sketches, by experienced Iron masters, of the most important iron establishments in the country, which shall embrace particularly all improvements of importance to the iron interest. These will be illustrated with practical working drawings and cuts, of such improvements, whenever it may be desirable. For the following cursory outline of the Albany Iron Works, we are indebted to one of the Editors of the N.Y. Tribune:

While in Troy, we visited the great Iron Manufactories in the vicinity, one of which is the most perfectly arranged in this country. One of the partners in this establishment, some three or four years since, made a tour through England, Scotland and Wales, for the special purpose of examining all the great iron mills. Thoroughly trained as an iron master, and prepared to appreciate every improvement, in machinery, furnaces, &c., he had blended the results of his observation of the British Iron Mills into a *plan*, in his estimation the *beau ideal* of an iron manufactory. He had no thought of being so soon allowed the opportunity to carry his plan into effect; but, very singularly, it so happened that the very day he landed in New-York, the rolling mill in Troy was burned down. With incredible dispatch he proceeded to build a new mill, in which should be executed the plan already alluded to. The building itself is brick, and is 365 feet by 145, which, with a projection on one side, covers nearly or quite *one acre and a quarter of ground*. One great object was to secure all the motive power needed, by using the waste heat of the puddling and heating furnaces. This is secured by placing the boilers in such a position that the waste heat passes under them, and the steam thus generated is conducted by pipes to the different engines in the building. In this way ample steam is obtained without cost of fuel for five engines, the aggregate power of which is 250 horse. There are 29 puddling and heating furnaces, so arranged as to furnish room for the workmen without *wasting* room (a common fault in rolling-mills), and yet allow free and easy access to the different stands of rolls, which occupy the centre of the building lengthwise. The balls as they come from the puddling furnace, are first flung into *Winslow's Rotary Squeezer*, an instrument which has met with favor in England as well as this country. Thence they are passed through huge rolls which crush them into rough bars. These are cut into regular lengths, which are faggoted, and again heated to welding heat, and rolled out into the larger sizes of iron, or the single pieces are rolled separately into the smaller sizes of merchant iron. Taking all these furnaces and stands of rolls under one roof—supported by beautiful but immensely strong truss-work—we have one of the most beautiful, if not the most beautiful Rolling Mill in America.

South of this is a new brick mill nearly completed, in the form of a cross —the length of one section of the cross being 173 feet, and that of the transverse section 163; the width of each section is 52 feet. In this building are eighteen puddling furnaces, a large train of rolls, the rotary squeezer, a machine-shop with lathes, &c. Here, as in the large mill, the waste heat of the furnaces produces steam to drive an engine of 150 horse power. The roof is supported by iron truss-work, and is covered with slate. In these two mills the raw material is converted into the various sizes and kinds of wrought iron for axles, nails, spikes, railroad chairs, and the general assortment of bar-iron; and the capacity of these mills to convert pig metal, will be inferred from the aggregate products of the establishment.

At the north end of the large mill are the furnaces, hammers, lathes, &c. for making car-axles, one of the most interesting departments of the business.

As we remarked in reference to the manufacture of car-wheels, every one who travels on our railroads has a practical interest in the strength and toughness of the axles. We had a practical illustration of this the other day, on the New-Jersey road. Our train was rushing along at the rate of 35 or 40 miles an hour, when an axle under the mail car gave way. One wheel flew out as if shot from a mortar, and the other dropt down flat, with the end of the axle pressed through the bottom of the car. Fortunately the wheel dropt on the rail and *slid along*. Had it caught among the ties, at the speed we were going, we must have been wrecked. One feels in such a situation the force of a remark made once in our hearing: *The manufacturer of car-axles needs to have "a quick conscience in his business."*

In the mill we are describing scientific knowledge, the best raw material, best scrap-iron, and the most skilful workmanship, are employed to make axles. The scrap-iron is already converted into wrought iron. This scrap is faggoted and rolled into flat bars. These bars are cut, and again faggoted in bundles of sufficient weight to make an axle of each bundle. Having been heated to welding heat, it is drawn down under the rolls and hammered to the requisite size. Every process through which it passes adds firmness and toughness to the iron, and it is a curious fact, that before pig iron becomes converted into axles it has passed through at least five processes, so that the iron when thus converted is regarded as perfect as any made in the mill, if not in fact the best. These facts are of interest to all who ride in cars. The axles made here are reputed—so we are informed by an experienced car-manufacturer—to be equal to the best in this country, and to be equal to any of British manufacture.

The two mills thus briefly described are driven entirely by steam produced from waste heat without cost for a pound of fuel.

A few rods above these mills we come to the original establishment, driven by water power, and now divided into four departments. The first is a *Rolling Mill*, 265 feet by 110, with three trains of rolls for spring steel, nail-rods, sheet iron, nail plates, and the smaller sizes of merchant iron. Connected with this is a steel furnace and smith-shop. Six heating furnaces supply the trains of rolls.

Immediately above this is an *Axle Factory*, for making wagon and carriage axles, crowbars, steel sleighshoes, &c. It is a brick building, 80 feet by 40, three stories high.

Above this is the *Nail Factory*, 150 feet by 35, in which are 55 nail machines, producing annually some 50,000 kegs of nails, and employing 75 men.

The *Spike Factory* is the last in the list, and is 150 feet by 46, has ten machines for making railroad spikes, three rivet machines, and produces probably 4,000 tons of spikes and rivets a year.

All the buildings are of brick, and covered by either tin or slate roofs, most of which are supported by iron truss-work very beautiful to look at, and very economical in the saving of room.

In comparing the present mammoth establishment with its beginnings, under John Brinkerhoff in 1809, we see vast enlargement, and also wonderful improvements in the various branches of the business. Thus, in 1809 Brinkerhoff, a prominent iron merchant in Albany, imported Russia and Swedes iron, which he had rolled into plates for nails. These plates were cut into nails by machines, but *the heads of the nails were made by hand.* It is said that nails by machinery were here made before any other place in the State.

The different items going to make up the business of the establishment make an imposing aggregate. 18,000 tons of coal—two thirds of which are bituminous—are consumed here per year, and probably from 20,000 to 25,000 tons of pig iron, smelted on the Lehigh, the Delaware and Lake Champlain, and not a small part of the best pig iron from the Salisbury (Conn.) Mines, smelted with charcoal. In all the departments 500 men find constant

employment, so that a population of over 2,000 persons derive their support from wages here paid out. The amount of wages is near $200,000 a year, or $16,000 a month. The mills produce of the various kinds of iron about 15,000 tons a year, worth in market nearly, or quite $1,000,000.

We have never seen the superior of these mills, especially the two we first described, in their economical arrangement of furnaces and machinery, so as to waste no room, and yet allow every branch of labor ample space. All the mills cover an area of two acres and a half. Half a million of capital is invested in the business, and it may be justly ranked as one of the first in this country. When the new mill is put in operation, which will be soon, the annual produce of the works will be greatly increased.

### AMERICAN IRON MOUNTAIN COMPANY.

The St. Louis *Republican* states that the American Iron Mountain Company have their furnace at the Iron Mountain in blast, producing an average yield of seventeen tons per pay, and some days as high as 18 tons of No. 1 foundry metal, blown with hot blast. The height of the furnace is 38½ feet, 9 feet diameter of bosh, and 3 feet funnel head. This great yield is attributable alone to the superior quality of ore, which yields about 56 per cent., consumes about 120 bushels of coal per ton of metal, and about eight per cent. of limestone.

### LAKE SUPERIOR IRON.

About 2,000 tons of iron and iron ore were sent down from Lake Superior last year. It is stated that the Cleveland Company could have sold $50,000 of ore if it had been in market. During the present year this company intend to ship 300 tons per day, and with the Eureka and other companies make the daily shipments from Marquette about 700 tons. These ores come in competition on the Lakes, with the ores from North-eastern New York, of which, during some years 30,000 tons have been sent westward. The freight is such that the Lake Superior ores can be sold at the lowest rate.

### MANUFACTURE OF AXLES AND PISTON RODS.

By James Fenton, Low Moor, York, Civ. Eng., Patentee, Dec. 16, 1854.*

The invention consists in a mode of manufacturing axles, piston rods, and shafts, girders, and other like articles, by rolling up or coiling a plate of iron of any required thickness and size into a compact roll or coil, next bring it to a welding heat in a suitable furnace, and then drawing it to the required shape under a hammer, or by passing it when at a welding heat through a pair of rolls. The welding may be carried completely through, or only partially, say half, through the mass; if the latter, a compound axle or other article will thus be formed, neither solid nor hollow, which it will be nearly impossible to break.

The manner in which the invention is performed is as follows:

A plate of iron is selected or prepared, of a suitable length, width, and thickness, to form a compact roll or coil, containing sufficient metal for the production of the intended axle or other article. The thickness, and consequently the other dimensions of the plate, will depend upon the quality of the iron employed. This plate is heated to a red heat (when needful), and two or more workmen, with tonges or pincers, turn up one of the edges; hammersmen then bend down this turned-up edge on the side of the plate, so as to form the commencement of a roll or coil; after which the operation is continued in the same manner until the whole of the plate has been rolled up, after which it may be passed through a pair of rolls, if considered necessary.

* From the Civil Engineer and Architect's Journal, Sept. 1855.

A compact roll or coil of metal being thus produced, it is heated to the welding heat in an air or other suitable furnace, and then welded and drawn down under a hammer to the form of the axle or other article required to be manufactured. The welding and shaping of the axle or other article may also be performed by passing the roll or coil of metal when at the welding heat between a pair of rollers, having sets of grooves of gradually decreasing diameter, in the manner commonly practised when rolling bars and rods of iron; or the roll or coil may be submitted first to a hammering process, and then passed between grooved rollers until it is reduced to the required shape. The plate of iron employed for forming a coil or roll which is to be manufactured into an axle or other article, may be a compound one, that is, it may be composed of iron of different qualities, and in this case the plate should be so rolled up or coiled, as to bring the iron of superior quality at the outer part or surface of the roll or coil. Two or more different qualities of iron may thus be combined in the same axle or other like article. In some bases also a small solid or hollow core or centre may be employed, and the plate of iron may be rolled up or coiled around this core until a mass has been produced of sufficient size for the production of the intended axle or other like article; the process of manufacture is then concluded as above directed. Although in the foregoing description only hand labor is mentioned as the means of rolling up or coiling the plates of iron into a compact roll or coil, in some cases machinery suitably arranged for the purpose may be also made use of.

*Claim.*—The mode of manufacturing axles, piston rods, and shafts, girders, and other like articles, by rolling up or coiling a plate of iron into a compact roll or coil, next bringing this roll or coil to welding heat, and then drawing it to the required shape under a hammer, or by passing it between rollers, or by a combination of hammering and rolling processes.

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IRON MOUNTAIN AND PILOT KNOB.

The Iron Mountain covers a space of about five hundred acres, and its summit is about two hundred feet above the base. Some idea may be formed of the elevation of this portion of the country, when we state that its *top* is eight hundred and seventy-eight feet above the city directrix, which is the base of the monument onthe curb of the pavement opposite the city stores, or twelve hundred and fifty feet above tide water. By a careful calculation, this mountain is estimated to contain *two hundred and twenty million tons of iron ore above the base.* The mountain, however, is not richer in ore than what is to be found beneath. An artesian well was commenced a short time since, and a depth of one hundred and eighty feet attained, all of which was iron ore, with the exception of a few feet of gravel and clay. How much farther this rich deposit extends can only be known by farther boring, but the quantity above the surface is sufficient for all time to come—the balance is a mere matter of curiosity.

The purity of the ore is as undoubted as its quantity, and yields about *sixty-five per cent.*

There are three furnaces, two of which are now in active operation; the last one built is pronounced by competent judges not inferior to any thing of the kind in the world, and all three are capable of turning out from eight to ten thousand tons of pig-iron annually. At present there is no necessity of pushing the work, as the furnaces turn out more metal than can be transported, the shipping point being Ste. Genevieve, which is forty-two miles, and the mode of transportation by wagons. This, however, will soon be remedied by the facilities which the Iron Mountain Railroad will afford, and which will make these mountains the suburbs of our city, and will give an impetus to the iron branch of manufactures, which as yet we can scarcely realize.

The Pilot Knob is a huge *iron* cone rising from a plain, and surrounded by

mountains upon every side, its base being almost a circle, and its top terminating in a point or apex like a sugar loaf. Its height is about five hundred and fifty feet, and its summit eleven hundred feet above the City Directrix, or about fourteen hundred and seventy-two feet above tide-water.

The works at the Pilot Knob are of the best material, and their capacity for turning out work fully up to the times, and the energy of its owners is equal to any necessity, no matter how great, which may be demanded of them. In addition to their furnaces, they have erected a forge, and although the works were not in operation during our visit, yet from personal inspection and from gentlemen who are practically conversant with the iron business, we are assured that they are not behind those in older mining districts, which have had the advantage and experience of years, yet are unfortunately denied the rich ore that lies so profusely upon every side of this favored region.—*Corresp. Miss. Repub.*

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ADIRONDACK (N.Y.) IRON.

I herewith give an answer to your inquiries respecting the special character and value of the Adirondack iron, with collateral matters. The most valuable iron ore of that region contains that proportion of the oxides of zinc and manganese which serves in the highest degree to free the iron from earthy constituents, when properly made, and adapt it for the best qualities of steel. In this respect the ores correspond to those of Sweden. The Adirondack Mountains and surrounding country are sufficiently covered by wood to supply charcoal for this best quality of forge-refined charcoal iron for steel. Seven thousand acres, if properly managed, are sufficient to grow timber for one charcoal blast-furnace.

To develop the full value of that region, connections by railroads must be made direct to the bituminous and the anthracite coal regions, and with the Juniata region. That produces iron of the same character as that of the Norway, of which large quantities are required in making up various manufactured wares, in which this is united to steel. By these railroad connections and the development of the Adirondack iron production, there would be ample facilities for the most economical manufacture of every class of iron and steel wares required in our country or for exportation. There would then be opened a circuit of country, surrounded by more natural wealth in iron than all Europe can claim, and in other respects, for the same extent, unequalled for resources and convenient access to all the markets of the country. The Adirondack region would produce the best steel in its variety; the Juniata would furnish refined rods and hammered iron; nearly every other variety of refined bars is furnished in Pennsylvania, New York, and New Jersey. For the toughest and cheapest cast iron, Lebanon County furnishes the exhaustless Cornwall ore, now shipped to nearly all parts of the State; for malleable cast iron, Crown point, the Housatonic valley and Orange County furnish ample quantities; and car wheel *chilling* iron is made at various localities; (these two last are not found in the British kingdom). In fact, the variety and uses of these irons from the finest to the coarsest qualities known, exceed in number all the applications of other metals; and all would be at command of the district lying within the circuit of central New York. In making this broad assertion, I must note that the American imitation Russia sheet has been improved several fold by one maker within the past year, and bids fair to rival the best of Europe. In this, as with every iron manufacture, American ingenuity can master success under a fair protection. Steel, and the minor iron manufactures, require in various processes the ready command of different fuels; here they could be obtained at the cheapest rates. For all the wares required—the variety of which is increasing and the most of which are now imported—there would be employment for many hundreds of thousands of people. At a glance it is evident, encouragement to these manufactures would improve every other *interest* in that and neighboring States—agricultural, mechanical, mercantile, *professional, mining,* and transportation.—*Corresp. N. Y. Tribune.*

COAL AND IRON TRADE OF SCOTLAND.

It appeared by the returns supplied by Mr. Williams, the Government Inspector of Mines for Scotland, that in the year 1854 there were 367 collieries at work in Scotland, of which 237 belonged to the west country; 171 being in Lanarkshire, 78 in Ayrshire, 11 in Dumbarton, and 7 in Renfrew.

The same returns show that during that year there were 7,448,000 tons of coal raised in Scotland, of which quantity 6,448,000 tons were raised from pits situated in the above-named four western counties. When we take into our calculations all the different varieties of coals raised, including splint, soft, and gas, the average price of which may be fairly estimated at 7s. 6d. per ton, the produce derived from the coal mines of the west of Scotland in the year 1854 may be safely valued at 2,418,000*l.* Of the quantity of coal thus produced, it appears that 2,152,800 tons were consumed in the manufacture of pig-iron, 367,200 tons in the conversion of pig into malleable iron, making altogether 2,520,000 tons employed in connection with the manufacture of iron. It further appeared that 926,221 tons had been shipped, and that 148,312 tons had been sent beyond the boundaries northward and southward by railways, leaving for general manufacturing consumption, for steam vessels, and for the domestic uses of the Glasgow district, 2,853,427 tons. The number of persons employed during the same period producing this quantity of coal was 22,980. While we thus find that this great development of the coal trade in Scotland is of comparatively recent origin, the manufacture of iron in the same division of Great Britain is still more modern, having obtained its present almost marvellous position during the last few years. So late as the year 1830 there were only 16 blast furnaces in the west of Scotland, and the whole produce of iron scarcely reached 40,000 tons; while, in the year 1854, there were 118 furnaces in full blast in Scotland for the smelting of iron ore, and the quantity produced amounted to 796,640 tons. Of the above 118 blast furnaces, 102 were situated in Lanarkshire and Ayrshire, 72 being in the former and 30 in the latter, and the produce of these amounted to 717,600 tons. Taking the average price during the twelve months of that year at 79*s.* 8*d.* per ton, the gross value of this rapidly progressing branch of industry is shown to have been 2,858,440*l.* Of this vast quantity of pig-iron produced in the west of Scotland, 122,684 tons were shipped direct to foreign countries, and 294,194 tons sent coastwise from the Clyde, Port Dundas, and the western ports of the Clyde Estuary, while 22,865 tons were sent away by railways, and 171,360 tons were converted into malleable iron, leaving the remaining 106,497 tons for foundry and other purposes of the district.

The number of men employed in iron mining in this district during the year 1854, was 3,645 in Lanarkshire, and 1,948 in Ayrshire, making in all 5,585; and taking the average wages at 22*s.* per week, we have an annual expenditure in the wages of an operative population alone of 319,633*l.* 12*s.* The number of men employed during the same period in managing and working the smelting furnaces amounted to 1,344, who received on an average 4s. 6d. each per day, making an additional annual aggregate sum of 110,396*l.* If, however, the manufacture of pig-iron be a modern industry in the west of Scotland, that of malleable iron is still more recent, for, with the exception of an attempt at a remote period to establish a small manufactory of that description at Wilson's Town, which was unsuccessful, scarcely any thing had been effected in this important branch until the year 1839; and even so recently as the year 1842 the annual production did not exceed 35,000 tons. The manufacture of malleable iron, however, in the year 1854 reached 122,400 tons; and taking the average price of all descriptions to have been 10*l.* per ton, the gross amount of this industry would thus have been 1,224,000*l.* The number of men employed in this branch was about 4,000, and the average rate of wages paid 28*s.*, exhibiting an annual aggregate amount paid in wages of 291,200*l.* Assuming these several statements and calculations to be as correct

as, perhaps, they could possibly be made, the real value to the west of Scotland of the entire of the iron industries, would not amount to less than 4,872,866*l.*; while the number of persons employed was 33,908, and the amount paid alone in wages 1,973,937*l.* It was thus conclusively shown by tables, the results of these returns, that the coal and iron works of the west of Scotland, of which Glasgow was the great central mart, produced to those employed in connection with the manufacture, no less a sum than 4,872,866*l.*, and gave employment to 33,908 persons, who received wages in return for their labor to the amount of 1,973,937*l.*

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# JOURNAL OF GOLD MINING OPERATIONS.

## SHIPMENTS OF GOLD FROM SAN FRANCISCO IN 1855.

BY STEAMERS.

| | |
|---|---|
| In January, | $3,949,235 46 |
| In February, | 3,245,970 34 |
| In March, | 1,715,977 48 |
| In April, | 2,965,644 56 |
| In May, | 3,077,554 85 |
| In June, | 3,859,168 81 |
| In July, | 4,178,180 61 |
| In August, | 5,515,906 12 |
| In September, | 4,072,885 52 |
| In October, | 3,823,887 27 |
| In November, | 3,258,701 72 |
| In December, | 4,306,987 41 |
| Grand total of steamer shipments for 1855, | $43,064,205 20 |

BY SAILING VESSELS.

| | | |
|---|---|---|
| To China—Gold bars, | $446,678 | |
| Coin, | 407,827 | —$854,500 |
| To East Indies—Doubloons, | | 154,737 |
| To South America—Coin, | | 47,910 |
| To Islands and Ports in Pacific—Coin, | | 100,258 |
| To Australia—Coin, | | 21,000 |
| Total shipments by sailing vessels in the year, | | $1,228,395 |
| By steamers in twelve months. | | $43,974,105 |
| Total shipments by both in 1855, | | $45,192,600 |
| Total amount of treasure shipped in 1851, | | $34,492,000 |
| Total amount of treasure shipped in 1852, | | 45,779,000 |
| Total amount of treasure shipped in 1853, | | 53,906,910 |
| Total amount of treasure shipped in 1854, | | 51,506,133 |
| Total amount of treasure shipped in 1855, | | 45,192,600 |
| Total amount exported in five years, | | $230,876,688 |

## DEPOSITS AND COINAGE AT THE SAN FRANCISCO MINT FOR 1855.

DEPOSITS.

| | | |
|---|---|---|
| Gold, | | Oz. 1,174,443 48 |
| Silver, | | Oz. 152,216 20 |

COINAGE.

| | | |
|---|---|---|
| Gold—For Coin, | $17,598,300 00 | |
| For Bars, | 5,250,594 83 | |
| For Ref. Bars, | 87,782 50 | —$23,957,677 33 |
| Silver Coinage, | | 464,075 00 |
| Grand total, | | $24,121,752 33 |

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## REFINING GOLD.

*Invention in the Process of Gold Refining.*—Messrs. Justh and Hunter, assayers, have adopted in their assay office in San Francisco, a late Parisian in-

vention of great convenience in gold-refining. This invention is the use of gas instead of the sand-bath in boiling the assays. In refining gold, after the yellow metal has been mixed with twice its weight of silver, the alloy is rolled out into a thin ribbon, and this ribbon is boiled in diluted nitric acid, which eats out all the silver and leaves the gold free from all base metals. This operation of boiling is a very delicate one; it must be done at a particular heat, and for a precise time.

The sand-bath was a quantity of ordinary sand in a large cast-iron basin, covered with glass frames, and heated by a coal furnace beneath. When any assays were to be boiled, the fire in the furnace was lighted, the sand was tried with the thermometer till it had attained the proper temperature, and then the fire had to be maintained just at that particular heat. The vessels fixed for boiling the assays are small glass retorts, with bulbs about as large as a hen's egg, and long necks. These retorts in the sand are always giving trouble, and when the assay is sufficiently boiled, they have to be removed. A Parisian chemist abandoned the sand-bath entirely, and adopted gas instead. The retorts are set in a frame over gas burners, which are flat on top, about an inch in diameter, and pierced at the sides for six very small jets of gas. A large number of these burners are placed side by side along the wall, and each is regulated by a stopcock, and there is another stopcock to shut off all the gas. One burner or all may be used, at the discretion of the operator, and when the assay is sufficiently boiled, he can leave the retort in its place, after removing the heat. The gas is far superior to the sand-bath; it is cheaper, cleanlier, more expeditious, takes less room, and is not so troublesome to the workman. Messrs. Justh and Hunter are, we believe, the first introducing this invention in the United States. It should at once be adopted in all the Mints, where it would save much labor, inconvenience, and expense.—*San Francisco Herald.*

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### MACHINERY FOR TUNNEL BORING.

The following appears in the Grass Valley (California) Telegraph.

The ingenuity of our mechanics, which has heretofore, in the way of mining inventions, been almost exclusively confined to improvements in quartz machinery, is now being turned to good account, in simplifying and reducing the labor attendant upon the tedious and heavy operation of tunnelling, pumping, &c., as applied chiefly to placer mining. In these improvements, Messrs. Gordon & Steen, of San Francisco, appear to be taking the lead. A few weeks since we gave a description of a new "Portable Pumping Apparatus," invented by them, the first trial of which is being most successfully prosecuted at Iowa Hill. This same firm is now getting up a new machine for tunnel boring, which is described by the San Francisco Chronicle as follows:—"The cutting is done by round plates of steel, about eleven inches across, by one inch in thickness, with a sharp edge. There are four of these plates, which revolve upon a common centre, and are thus carried around and around in the tunnel, touching the rock at a low angle. The machine has been tried in the hardest granite, and a hole seventeen feet in diameter was bored in that material, five feet nine inches deep, in twenty-four hours; and if the tunnel had been five and a half feet in diameter, the distance pierced ought to have been fifty feet. An engine of sixteen horse power will be needed to bore a five and a half feet tunnel. The machine of that size will cost about $6,500, without the patent right. At present the purpose is not to sell the machines, but to form a Company for boring tunnels, and bore them at a certain price per foot."

## EXPERIENCE IN GOLD MINING.

Rutherford Gold Mines, North Carolina, January, 1856.

To J. P.*

Dear Sir:—Your ready response to my earnest call for information from those practically acquainted with the working of gold ores, leads me to be equally prompt in replying to your inquiries. From the brief outline which you give of the early history of the mine upon which you are engaged at present, I can easily perceive that your experience has led you to the same point to which my own has conducted me, and which I believe many others than ourselves have also arrived at. The time has now arrived, when the facts in regard to our avocation, are eagerly sought after, from as many varied points of observation as can be reached, and that a mutual interchange of ideas, and the results of actual experiments, cannot fail to be productive of personal satisfaction; but, what is far more important, have a tendency to place gold mining upon that sure and practical foundation, which must remove from it the odium of a chimerical and speculative character which now invests it.

I ardently hope ere long, to see this important branch of mining divested of all those extraneous burdens which have been forced upon it, and to find it pursued in its legitimate sphere, with sufficient capital to work out results, and guarded by those engaged in it, with a scrupulous regard to close economy, and a rigid and business-like attention, guided with sound common sense, and an unceasing watchfulness and observation of all attendant phenomena. A daily record of even the most trivial facts, may lead to results at last, wholly unanticipated, and throw a light upon points which else would remain obscure.

Upon this mine, since it has been under my superintendence, we have been crushing the ore with one of "Bullock's Quartz Crushers." The ores are hard compact quartz, interspersed with nodules of decomposed iron pyrites, holding the gold in mechanical intermixture, usually in grains of extremely minute division, but sometimes of size sufficiently large to be visible to the eye. When in this latter state, the gold is of a leaf-like character, and consequently liable to float away in the washing process. We started our work in July last, and in six weeks, with a force of about thirty hands, drove seven hundred and fifty feet of levels—the lowest depth seventy-five feet—and raised about four hundred tons of ore. I endeavored to keep in view the fact, that it was *ore* we were striving to obtain, and consequently, it was necessary to avoid dead work as much as possible. We hauled our ore to our mills, about half a mile, in boxes made tight and strong, iron bound, but open at the top, and of capacity to contain about two hundred pounds of ore. We placed a sufficient number of these upon each wagon to make a load. The ore was fed into "Bullock's Crusher" at first, at the rate of about two and a half tons per hour. This was reduced to a fine slime, and was passed through a trough, which discharged into twelve stirring bowls, of three feet diameter, about nine inches deep, with a point of discharge in the outer rim about two inches from the bottom, and the central shaft carrying four arms, with fingers six inches long, two inches wide and two inches space between each finger; the fingers upon each alternate arm being so placed as to follow the space left between the fingers in that which preceded it, and running within one eighth of an inch of the bottom. These bowls discharged, four of them, into one rocker. The rocker carried a circle of about thirty-six inches in the clear; with riffles about half an inch deep, four inches wide, and one foot apart. I soon found that the ore was being "rushed" too fast for our amalgamating force, and that we were wasting good ore by trying to force the work too rapidly. From subsequent and careful trials made upon given quantities of ore, I have obtained a value of eleven dollars and twenty cents per ton, and

* See December No., Vol. 5, p. 536.

am convinced that much gold was not saved, but was washed away with the sands. These sands I saved in tanks, however. For some two or three months I did nothing but try various experiments with the ores, and without following out the minutiæ of them all, I would give the general results to which they led me. 1st. The gold is disseminated in such minute particles through the iron pyrites, that to effect its liberation the ores must be reduced to an impalpable powder. 2d. The slime thus produced must be worked in the course of amalgamation, *in the slowest possible manner*, to allow these minute particles to be brought into prolonged contact with the quicksilver. 3d. Analysis has shown me that the iron pyrites may be divided into two classes, one of which is magnetic, and is formed of *one* atom of iron and *one* atom of sulphur. The other is not magnetic, and is constituted of *one* atom of iron and *two* atoms of sulphur. Hatchett, in his remarkable analysis of iron pyrites, has drawn the conclusion that the iron and the sulphur are mechanically and *not* chemically combined. Consequently, 4th, if the iron pyrites can be exposed during the manipulation of the ores, to any oxidizing influence, the liberation of the gold must be proportionably consummated.

The foregoing conclusions have led me to my present position: asking for information from those who can give it, and preparing the following machinery, at the same time. No better, nor, in fact, more capable crusher than that of Bullock's having met my view, I retain that as a reducing power for the ores. As the ores are ground to the required fineness, they are discharged into a large tank of the following dimensions: ten feet wide, six feet deep, and eighteen feet long. This will be divided by two partitions crossing it, into three tanks, of ten feet by six feet surface and six feet deep. The top of the tanks will be level with the floor of the building. The ore, as ground, will be discharged into the first tank; when that is filled, the ore will be conducted by a trough across the first and discharged into the second: the third will be filled in a similar manner when the second is also full. Each of these tanks will contain about twenty tons of sands, or about twelve hours work of the crusher. Over each tank an additional discharge of water will be thrown down, through a perforated disk, to cause a vertical agitation of the water in the tank, to throw down any minute particles of gold that may be floating upon the surface. This action will be similar to that of sprinkling with the hand, the water in the pan, while panning. The two first tanks will be filled with the ground ore, before amalgamation will be commenced, so that when the sands are removed from the first tank, they will have been crushed two days, and so afterward with the contents of each tank. As the sands are being discharged into the tanks, some common salt will be added from time to time, sufficient to render the water slightly saline to the taste, and to produce by the salt an oxidation of the iron.

The amalgamating apparatus will consist of eight Arrastres, such as are termed in Mexico, "de marca," carrying four stones each. They will be six feet in diameter, will be fed from the upper portion of the outer rim, and will discharge *through the centre*, into a trough, which will connect with four stirring bowls to each Arrastre, making thirty-two bowls in all, same as used heretofore at this mine, except that they will carry but two, instead of four arms; these bowls will also discharge through *their centres* into a long tank. From this tank the sands will be fed by hand into the rockers, thence discharged into tanks, and subsequently be thrown into heaps, to undergo such changes as may be produced by atmospheric agencies, and they may hereafter be rewashed, should experiments prove it advantageous to do so. The amalgamating process will continue in operation both day and night. A shaft fifty feet long will be used for driving the Arrastres; they will be placed side by side, and each Arrastre driven by a separate belt and suitable gearing, and the four bowls accompanying each Arrastre, be kept in motion by belts driven from the Arrastre shaft; by this arrangement any one of the Arrastres can be stopped at any time without interfering with the movements of any of the others. For the purpose of "cleaning up" the Arrastres and bowls, a small

aperture will be left in the rim, at the bottom of each, through which the sands and amalgam will be washed by a stream of water passing through a flexible hose; when not "cleaning up," of course, this aperture will be securely closed. The separate motion of each Arrastre will be peculiarly advantageous in this stage of the process.

The Arrastres will be fed by hand, at the rate of two bushels per hour; to insure uniformity of feeding, a small trip hammer will be so arranged as to strike at such intervals of time, as will coincide during the hour, with the number of measures of sands which will amount to the two bushels; one of which measures of sands will be put into the Arrastre at each blow of the trip hammer. Regularity and uniformity of labor are essentially requisite at this stage of the process. In fact, experience has shown that far better results are obtained, by slow and regular action, throughout the whole of the amalgamating operation. More gold will be obtained from two bushels of sands, fed into the Arrastre in this manner, in the course of an hour, than would be derived from the same quality and quantity of sands if placed at once into the Arrastre and worked for the same length of time.

While the sands are passing through the Arrastres, some wood ashes, freed from charcoal by sifting, will be occasionally added. as experience has shown that the tendency of such a course is to keep the quicksilver bright and active. I cause the Arrastres and stirring bowls to discharge *through the centre* for this reason: as soon as the sands enter the Arrastre or bowls, their specific gravity causes them to fall at once to the bottom: there the centrifugal force of the drags throws them toward the circumference, producing an under current in the water, which must be counterpoised by a surface current to the centre. Should the agitation of the water be such, that the coarse sands would be liable to be discharged over the rim, if the Arrastres were constructed to discharge these, as they usually are, by having the discharge in the centre, it is evident that the heavy sands would again subside while following this upper current, and nothing be sent out but such sands as had been sufficiently reduced to be allowed to pass into the bowls. By this arrangement the "floured quick" will also be retained, and recombined with the fluid metal. In all horizontal rotary manipulations, the above plan of central discharge will be found to be the most productive of favorable results.

I would further state, that at each step of the operations I cause fresh, clear water to be introduced; as the less the water is impregnated with foreign matter, the more readily the gold will sink through it. The sprinkling apparatus is placed over every tank. You have now a brief sketch of the plan I am putting into operation, and the reasons upon which it is based. I hope soon to be able to state results.

My experience with "Stamps" coincides with yours, that except for coarse gold, they are not suitable for gold ores.

The point you mention about the supply of water at different stages of the Chilian mill operation, is one that has never attracted my attention. I regret that on this point I cannot give you the information you desire, but I have seen greatly increased returns arise from the occasional introduction of quicksilver into the Chilian mill while grinding the ore, accompanied by a careful and cautious method of slowly feeding the mill. Perhaps this fact will be new to you; "the Chilian mills are always used in Chili, to grind the ore dry, and not as you use them, with water." *M. S. Correspondence.*

My views upon the "Rocker" will soon be sent to the *Mining Magazine*, and will form one of a series of papers upon "Gold ores and their Working."

Allow me to express the hope that our correspondence may not cease here; and that, perchance, a personal acquaintance and interchange of views may happily arise from our similarity of pursuits.

Very respectfully,

Yours, &c.

STEPHEN P. LEEDS.

REDUCTION OF AURIFEROUS QUARTZ.

"We have had an opportunity, during the week, of visiting the laboratory of the Royal Panopticon of Science and Art, to witness some experiments by Mr. Harris, of Dolgelly, assisted by Mr. Ansell, the professional chemist of the institution, for the economical extraction of gold from its matrix. The process is, we believe, a modification of an old German method, aided by the extensive experience and important chemical discoveries of modern times. The ore is from the Chancellorsville Mine, in Virginia, a quartz deeply covered with the red oxide of iron; this is first calcined, and reduced to an impalpable powder, which is then placed in a glass retort immersed in a cistern of water, kept up to boiling temperature; this is connected by glass tubes, with a generator, in which chlorine gas is produced by the decomposition of the black oxide of manganese, acted upon by hydrochloric acid. This gas passing through, and thoroughly saturating every particle of the gold dust, hitherto invisible, converts the same into a soluble chloride of gold. The sand is then well washed, the chloride consequently dissolved, and a stream of carburetted hydrogen being passed through the solution, precipitates the metallic gold in the form of a deep purple powder. In one portion of the apparatus a particle of leaf gold was placed in a glass tube, to show the effects of chlorine on metallic gold, and which was rapidly acted upon by it, being converted into a beautiful green chloride, lining the inside of the tube like a web. The process is expected to be very economical on a large scale. —*London Journal.*

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# JOURNAL OF COPPER MINING OPERATIONS.

## THE BRISTOL COPPER MINE.

### IV. THE PRESENT POSITION OF THE MINE.*

Since the introduction of the Bradford separators and the systematic workings of the great flucan, the mine has returned handsome monthly profits. It is safe to state these profits as about $1,800 per month, over all expenses.

The average monthly expenses are now about $2,250, including repairs of and additions to machinery, and the salary of the Manager. The expenses for the month of July last, gives us a fair specimen of the items which make up this cost. We copy from the Journal.

| | | | |
|---|---|---|---|
| Underground Labor, | | $799 66 | |
| " Materials, | | 17.90 | |
| " Timber, | | 23.88 | |
| " Candles, | | 30.99 | |
| " Machinery, | | 118.73 | |
| Total Underground Cost, | | | $990.66 |
| Surface, Dressing Ore, | | $708.50 | |
| Dressing Machinery (repairs), | | 92.44 | |
| Wood for Steam Engine, | | 80.00 | |
| Total Surface Expenses, | | | $880.94 |
| Miscellaneous, Assaying, | | $25.00 | |
| Jobbing, 5.04, Stable 30,00, | | 35.04 | |
| Store Keeper, | | 30.00 | |
| Oil, | | 49.29 | |
| Salary Manager, | | 140.00 | |
| | | | 379.33 |
| Total Expenses for July, | | | $2,250.93 |

The average yield of ore per month is 30 tons, which at $135 per ton, present price, is equal do $4,050, being a profit of $1,800 over the expenses.

* Continued from p. 91, vol. VI.

The present limited machinery and shaft are now worked to their full capacity both day and night. In determining, therefore, the practicability of increasing the present product of the mine to an amount which will speedily return the former cost of the plant and leave a profit for the adventurers, it becomes requisite to examine critically the resources of the mine as *at present known.*

### V. RESOURCES OF THE MINE.

We have already described the geological position of the ascertained ore ground of the mine. Its resources are comprised under the following items, viz:

1. Value of the great Flucan, within ascertained limits.
2. " " ore in the crystalline rocks.
3. " " ore in the sandstone.
4. " " Halvans on Surface.
5. " " Raft on Surface.
6. " " the real estate and plant of the mine.

We will consider these several items separately, and then make a summary of the results.

1. *Value of the flucan.*—The width and extent of this ore channel have been already described. It has now been the subject of long-continued and successful explorations, and so many assays and mining "vans" have been made of its contents, that we are no longer in doubt as to the approximate amount of its metallic contents, especially as the whole product of the mine has now been derived from it for two years; and the records of the smelter show that the value predicated upon it is actually obtained in practical working.*

The average of thirteen humid assays of the flucan taken from the various levels and cross-cuts made by Mr. Stadtmuller in 1853, show 1.103 per cent. of metallic copper, or about 3.67 per cent. of 30 per cent. ore. Fourteen assays of samples collected by ourselves in May of this year, show an average of 2.65 per cent. of ore, as may be seen in detail in the annexed table:

| Locality of Samples, of which 8,840 or 5,760 grs. was vanned. | Weight of Ore obtained by van. | Per centage of Ore obtained. | Metallic Copper obtained by assay |
|---|---|---|---|
| **Great Flucan North Run.** | | | |
| 20 fathom level. " " | 5¼ dwts. | 2·29 | 24·60 |
| " " | 4¼ " | 2·85 | 24·22 |
| " " | 2·11 grs. | 1·02 | 11·64 |
| " " | 5¼ " | 2·29 | 23·96 |
| " " | 9·6 " | 5·78 | 44·63 |
| **South.** | | | |
| 30 fathom level. Foot of ladder in winze, | 6·15 " | 4·14 | 35·36 |
| " another, | 4· " | 2·49 | 30·60 |
| Cross cut, | 4·11 " | 2·78 | 21·01 |
| Davy's level S. of cross cut | 4·12 " | 3·90 | 31·47 |
| " " " | 3·11 " | 1·95 | 19·19 |
| Cross cut near sandstone, | 6 " | 2·50 | 38·05 |
| Bottom and cross cut, | 3·3 " | 1·30 | 40·96 |
| Another " | 3·1 " | 1·26 | 14·97 |
| Averages, | | 2·657 | 28·08 |

Ten humid assays by Mr. Storm, the present mine assayer, of the weekly averages of the work done by the crushers and stamps in July and August of the present year, show an average richness of 1.17 per cent. metallic copper, equal to 3.90 per cent. of 30 per cent. ore.

* The fact that the flucan contained ore was not overlooked by the former managers of this mine; but it was supposed to be impracticable either to take it down safely or to work it with profit. The new modes of mining and dressing—in which the Bradford Separators serve a most important purpose—have now rendered this an easy and certain operation.

The weekly averages of the results of stamping and crushing are obtained from small hourly portions of stuff put aside by the attendants on each of these processes. These quantities are then carefully sampled by the captain of the mine, and a weighed quantity of each is subjected to the "*van.*"* Such an average is plainly much more perfect than any other that can be obtained. The results of these trials for the 22 weeks ending August 13th, give the following:

| | |
|---|---|
| Average from the crushers, . | 3.04 per cent. of 30 p. c. ore. |
| Average from the stamps, . | 2.52 |
| Mean of the two, . . | 2.68 |

The summary of all these modes of trial is as follows:

| | |
|---|---|
| By Stadtmuller in 1853, . . | 3.66 |
| By ourselves in 1855, . . | 2.65 |
| By mine assay, " . . | 3.90 |
| By captain's van, { Crushers, . | 3.04 |
| By captain's van, { Stamps, . | 2.34 |
| Mean of the five modes, . | 3.11 per cent. of 30 p. c. ore. |

This average of ore is equal to $\frac{93}{100}$th of one per cent. of metallic copper in the flucan. But as all the ore cannot be obtained by washing, even with the present improved modes, we will reduce the probable yield to 2.5 per cent. of 30 per cent. ore. This amout will undoubtedly continue to be realized in working on the large scale, as it has been heretofore. The ore actually sold this year returns $2\frac{51}{100}$ per cent. to the whole amount of stuff worked over, which is a surprisingly close approximation to the calculation just made, and to the average of the captain's vans.†

Estimate, then, a body of this ore-ground actually seen and measured as 500 feet long, 33 feet average width and 240 feet deep, and weighing by trial 150 pounds to the cubic foot, and we have a total weight of rock, of 252,551 miners' tons of stuff, yielding equal to 6,313 tons of 30 per cent. ore. This at present prices, $135.00 per ton, will yield . . . . . $852,255.00

Less, mining and dressing and all expenses, at $1.40 per ton on 252,551 tons,‡ . . . . . $353,571.40

Leaving for net avails from flucan, . . . . . $498,683.60

2 & 3. The value of the ore in the crystalline rocks or in the wide belt of ore ground adjacent to the flucan, and already described, it is impossible to estimate accurately. As the flucan is withdrawn, the old arches now standing over the galleries and passages of the mine will fall, and be brought up in rich fragments, as is the case at present daily. Many rich spots for exploration have been noted in our survey under ground, which in the continued work-

* The term is applied to the method of washing ores on a shovel, called a *vanning shovel;* and in which operation a skilful miner can usually obtain better results than are obtained by the ore-dressing machinery.

† Some persons who may see this Report, may be surprised that a mine can be worked at a large profit whose ores are of so low a per centage. It is well, therefore, to make a few comparative statements.

The yield of the copper mines worked so extensively in Russia, in the Permain Rocks, is only 2½ per cent. of ore. The mines of Mansfield in Prussia, yielding a large profit, contain a much smaller per cent. than this.

The whole copper ores sold in Cornwall for 1854 were about 180,000 tons, yielding some 11,000 tons of fine copper, or about 6·5 per cent. metal to the ores sold after *they were dressed for smelting;* and for the month of June, 1855, the average richness of the dressed ores was only 5 per cent. As the Bristol ores are dressed at 30 per cent. from an ore stuff equal to a little less than one per cent. of metallic copper, some notion may be formed of the low percentage of the whole ore stuff moved to obtain the British ores, which are dressed only to 5 or 6 per cent. And yet the Cornish copper mines last year divided over $10,000,000 of profits on the year's business. It should also be remembered, that the vitreous and variegated ores of copper, which are the ores of B. M., contain respectively 79 and 69 parts of copper in the hundred parts, while yellow copper, (the prevailing ore of Cornwall,) if pure, contains but 34·46.

‡ The present cost of mining and dressing, with the absence of tram roads below and on the surface, and other conveniences for economical management, has been about $1,80 per ton. A careful calculation of the cost of mining with the proposed improved facilities, shows that it may be done, if threefold the present quantity is mined, all told, for $1,37 per ton. If fourfold the present business is done, the expense will probably be even less than that; but we have adopted the above sum ($1,40) as a safe and reliable one.

ing of the mine will all come to the surface; the Manager and the Mining Captain express the conviction, that as much ore remains now standing in this ground as has been formerly taken out; and on that supposition have estimated the returns of this portion of the mine at $200,000, and the vein in the sandstone at $15,000. While we cannot add these items to our estimate of the resources of Bristol Mine with the same certainty as in the case of the flucan, it is quite safe to express our conviction that there will be great returns from this portion of the ore ground. Probably the net avails from these sources should reach $100,000 above the 40 fathom level.

4. *The halvans.*—During the early history of the present enterprise, and when the dressing machinery was very imperfect, much ore was rejected, which can now be worked over to a good profit. Very large accumulations of this material exist on the surface, and from a superficial measurement and the explorations we have caused to be made in sinking a shaft in the heap, we assume this material will probably return net $15,000.*

5. *The raft.*—A survey of the vast raft heaps (the result of former ore dressings) on the south of the present works, show that they contain about 6,800 miner's tons of material, all in a state of fine division and impregnated with copper. Fortunately we are not left to conjecture as to the probable value of this accumulation of the refuse of former workings. We possess over one hundred assays made, sometimes daily, during 1849 and 1850, by Mr. Stadtmuller, former assayer to the mine. The average of all these assays gives us $1\frac{55}{100}$ per cent. metallic copper for the whole, equal to 325½ tons of 30 per cent. ore, worth over $45,000. As the material is already on the surface and in condition to be economically dressed, the expense of working it over will not exceed by calculation 35 cents per ton.

By comparing the earlier and later assays of this raft, it will be seen that as the means of dressing ore was improved, the raft became poorer. Thus in 1849 it was for the year 2.61 per cent. copper, and on the 27th of October, 1849, it was 5.32 while in 1850 it averaged 1.51 per cent. In the year of greatest productiveness of the mine (1848) there were no assays of the raft.

In this estimate no account has been taken of the value of the material now on the old dressing floors, and accumulated in various ways and to a notable depth about the present buildings, all of which will, in the proposed new arrangements, be profitably worked over. We set the probable value of the raft and of the surface waste at $40,000 net.

We have then the following summary of the resources of the Bristol Mine in ore, after deducting the expenses of working, &c.

| | | | | |
|---|---|---|---|---|
| 1. | Value of the | Flucan, | | $498,683.60 |
| 2 & 3. | " | " | other ore ground, | 100,000.00 |
| 4. | " | " | Halvans, | 15,000.00 |
| 5. | " | " | Raft, &c., | 40,000.00 |
| | | | | $653,683 60 |
| 6. | " | " | Plant of the mine, estimated as | 200,000.00 |
| | | Total, | | $853,683.60 |

It will be seen that this estimate takes no account of the discovery of new deposits of ore in future explorations, nor of the continuance of the flucan and other ore ground in depth. Although it is in the highest degree probable that the exploration of this deposit to the hundredth fathom will confirm our opinion in its continued richness, we will not permit this circumstance to affect our estimate, the object of which is to show that there is ore enough in sight to authorize placing the mine without delay upon new basis of sufficient extent to enable its proprietors to realize most satisfactory returns.†

* This estimate rests on an area of 150 feet diameter and 10 feet deep of stuff of the same richness as the flucan. It will, from present appearances, exceed the flucan in richness.

† A statement has been circulated in the public prints that the discovery of a new deposit of ore had been made at Bristol valued at one million of dollars. This statement is, no doubt, founded upon the testimony given before the Legislative Committee in May, that there were probably over a million dollars worth of ore now standing in the mine. If the *gross* sums just enumerated are added up, it will be seen that this statement is confirmed.

VI. BRADFORD'S SEPARATORS.

As the present and future success in working Bristol Mine are closely dependent on the use of new and improved machinery, of which the ore separators of Mr. H. Bradford form an important part, it becomes interesting to examine with critical care, the operation of these machines, as exhibited in the experience of this mine since February last. The results of these operations, as well as those of the whole mine, are accurately registered at the close of every week and tabulated in printed forms.

From the 17th of February to the 21st of April, (11 weeks,) when only seventeen of these machines were in action, 78,201 pounds of ore were separated by them in 1,378$\frac{41}{100}$ hours. This makes the hourly product of each machine 3$\frac{163}{1000}$ pounds, or 79$\frac{272}{1000}$ pounds for a full day of 24 hours.

From the 22d of April to the 28th of July (13 weeks), 18 machines produced 102,925 pounds of ore in 1,723$\frac{1}{2}$ hours' running time. The hourly produce of each machine for this period was therefore 3$\frac{243}{1000}$ pounds of ore, or for the full day 77$\frac{832}{1000}$th pounds. The average of these two products is 78.55 pounds per day for each machine, if full time was run, of ore estimated at 30 per cent.

There was however a loss of 6 per cent. of time on the first period, and of 7 per cent. on the second, and the product of the machines is therefore subject to a like deduction.

The absolute or actual average for each machine was therefore for the first period of 11 weeks, 73.384 pounds, and for the second period of 13 weeks, 74.516 pounds. Mean for the whole time of 24 weeks, 74 pounds of ore daily for each machine.

The whole amount of stuff dressed upon the separator is obtained indirectly as follows. The total weight of ore stuff dressed during 122 days, as drawn from the records, was 11,948,900 pounds of rock stamped and crushed, or 5,080 tons miner's weight. The total ore sold from this quantity of stuff, was 128 gross tons (2,352 lbs.) or 2.51 per cent. of the stuff worked over. By the Captain's vans the average richness of the stamp work (forming much the larger part of what goes to the separators) for 22 weeks was 2.32 per cent. The humid assay of the average work from the stamps for five weeks in July and August, gave for the richness of the stuff dressed on the separators 3.28 per cent. of ore, or .984 of metallic copper. There is therefore an apparent loss in the tailings of .77 per cent. of 30 per cent. ore, or $\frac{23}{1000}$th of copper. The amount of ore however lost in the tailings, does not exceed $\frac{4}{10}$ to $\frac{6}{10}$ per cent. or about .15 per cent. of copper. The actual products of working, therefore, as may be seen, exceed for the machines, the average richness of the Captain's vans.

Of the total ore produced in this time, 181,126 pounds came from the separators, and 160,858 pounds from the jiggers. The whole amount of stuff therefore required to produce this amount of ore, estimated from the above ratio (1.15 : 1), is 7,686.80 pounds. This may be taken approximately as the actual quantity which passed over the separators, and if calculated on the Captain's vans, it should have produced 177,961 pounds of ore, while in fact it did produce 181,126 pounds of ore, a truly remarkable coincidence, being in fact a variation in excess for machines of only 3,210 pounds. Each of the separators therefore dresses about 1$\frac{1}{2}$ tons of rock daily, of stuff yielding an average of 2.5 per cent. of 30 per cent. ore.

Undoubtedly Bradford's separators are the most important mechanical invention ever produced for dressing what are called slime ores. The principle upon which they are constructed is truly philosophical, and has been most ingeniously applied by the talented inventor to the production of this machine. Like all accurate instruments they require careful adjustment in all particulars, but once adjusted they are completely self-acting, so that one attendant can easily oversee at least twenty of them.

VII.—PRESENT SURFACE ARRANGEMENTS AND DRESSING MACHINERY.

The only motive power employed about this mine is water, with the exception of a single horizontal high-pressure engine of six-horse power, which is used exclusively for working the eighteen Bradford separators, and the necessary elevating and other machinery attached to them.

The water power is derived from a small stream to the north-west of the mine, from which the water is brought by a canal four fifths of a mile in length. There are two wheels, the water being used twice. The upper one is near the engine shaft, and is 32′ in diameter, and 6′ breast. This wheel is used to drive the crushers and stamps, and for hoisting the ore. The lower one is 34′ in diameter and 12′ breast, and is employed for pumping at the engine shaft, the power being conveyed to the shaft by a flat rod 1,300 feet in length, and running on friction rollers. Both wheels are in good order; the lower one was built in 1853, in the most substantial manner, and is well housed. The supply of water is abundant, except during the Summer months, when, if the season is dry, the power is not usually sufficient to move all the machinery at once. There appears to be no available supply of water to make good this deficiency, and auxiliary steam power must be resorted to for this purpose, and will, at all events, be necessary, in case of any increase on the quantity of machinery now in operation.

The ore is hoisted by a whim of a form of construction believed to be peculiar to this mine. The power is applied to an endless screw by means of friction wheels, so contrived as to admit of instantaneous reversal, without any change of motion on the part of the driving machinery. On arriving at the surface, the ore is divided into two classes—the soft flucan and disintegrated rock goes to the stamps, the fragments and masses of solid rock containing disseminated particles of ore are destined for the crushers. If the whole contents of the kibble belong to the first class, they are dumped into a wagon at an elevated landing, and conveyed on a tram road to the stamps at a distance of about 100′. If the kibble contains mixed flucan and solid rock, the contents are shot on to a dressing floor, the soft part is separated by a man in attendance, and conveyed to the stamps; the remainder is thrown on to the crusher, after having been spalled or broken in fragments of suitable size. There are two crushers in use; the first one breaks the fragments into pieces of the size of the fist; the second reduces them to a coarse powder, for which purpose the stuff, as it passes the crusher, is screened; the coarser portion, or that which does not pass through the meshes, being conveyed by an elevator back to the crushers, while the finer particles are raised to a higher floor, where they are mixed with water and then screened. The size of the meshes of this screen is 40 to the inch, and all that does not go through these meshes is separated by jigging, while that which does pass them is mixed with the slime from the stamps, and goes to the Bradford machines. The jigs are four in number, and are worked by hand.

There are 4 batteries of stamps of five heads each; the stamp head and beam weighing about 400lbs. each. The gratings have ten apertures to the inch. The stuff as it passes through them, is moved by an Archimedean screw in the direction of an elevator, which takes it up to the screens. These are two in number, 22 and 60 holes to the inch, and assort the material for the Bradford separators, eighteen of which are now in use.*

P. S. Since the above date, experiments have been made at the Bristol mine, in the use of Bradford's jigs, which promise to be of great importance in the economy of time and labor in ore dressing. It is found that when the whole product of crushing or stamping is fed to these machines, that a concentration of the metallic sulphurets is made to such an extent, that nine tenths of the whole weight of raw material is passed off as a valueless waste,

* A new form of jig invented also by Mr. Bradford has just been put at work at Bristol, and so far as it has been tried, has yielded the most satisfactory results. September 10.

while all the ore is obtained in one tenth which is collected in the Hutch with a portion of fine sand in a state to be very easily raised to a high percentage on the separators. The abridgment of labor and cost in mining by this mode of proceeding is very important, and can be easily appreciated by those who are familiar with ore dressing processes. This jig is fed by a steady stream of water conveying ore, and its construction is such as to permit the waste to pass of continuously on one side through apertures provided for it, while the ore collects in the Hutch. For this purpose the Hutch is divided into two compartments by a vertical division, of which one side of the screen box forms a part. This jig is operated by machinery.

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LAKE SUPERIOR REGION.

The irregularity of the mails has been greater this winter than usual, and the severity of the season on Lake Superior has been almost unprecedented. The failure of the supplies sent forward for many of the mines, to reach their destination has caused much embarrassment. The Miner thus states the

*Percentage of Lake Superior copper.*—The Minnesota copper has always been of comparatively high purity, but has never yet reached 80 per cent. Her last year's product at the Detroit Smelt works made 72 per cent. of ingot copper. The Norwich, if we recollect aright, was a mere shade above this. The Cliff copper is smelted at Pittsburgh, and yielded last year only 45 per cent.; and though the rough copper sent down by this mine considerably exceeded that of the Minnesota, yet the ingot copper was less by 30,000 pounds.

Very large masses and *headers*—viz., pieces of half ounce or more weight, which, as they cannot wash away from under the stamp heads, are beaten until they are almost entirely divested of the rock—these may sometimes approach closely to metallic purity. But it would require much more labor mechanically to detach the rock from the copper, after you have brought it to 70 or 75 per cent., than to get rid of it by the simple process of smelting.

*Shipment of Eagle Harbor.*—The amount of copper shipped from Eagle Harbor the past season, was from the Copper Falls Mine 151 3-5 tons: North-West, 101; North-Western, 77 3-4: Central, 53; Summit, 1 3-5; total 384 3-4.

*Garden City Co.*—The "Garden City Mining Co." is a new corporation which commences operations in the Lake Superior region. It was incorporated in October last, with a capital of $500,000, divided into 20,000 shares. Among the incorporators we notice the name of S. W. Hill, of Michigan, who is also the Superintendent of the Co. The lands owned by this company, in which they propose to commence mining in the spring, are composed of two tracts, called the "Kelliher" and "Hill" mines, near Eagle and Agate Harbors, Lake Superior, in the midst of the great copper district of Keweenaw Point. They propose to commence mining in the "Hill mine" (which is but one mile from the port of Eagle Harbor,) as soon as practicable the ensuing spring.

*Phœnix Mine.*—Mr. BUTLER of the Phœnix Mine, is quite sanguine of the success of that Pioneer establishment. The old vein south of the bluff near the Eureka Mine has been penetrated to a depth of 100 feet below the "slide," and the work here suspended. All the stuff now raised is from the old works, at shaft No. 2, not far below the river level, in what has been called the scoriaceous or "ash bed" of the Copper Falls location. In this bed the first works were commenced, and from which so much copper and *silver* was taken that the stock rose to $4,000 a share.

This was in 1845—6. Dr. JACKSON regarded it as a good vein *without walls*, and working through the bed to the south, the stockholders and agents were greatly astonished to see the copper giving out. Some 15 or 16 tons were taken out, principally in lumps and loose masses among the gravel and boulders, that covered the rock of the true vein. A sand drift more than

200 feet long, was made in the gravel on the surface of the rock, and directly beneath the bed of the river. The agent is now stoping each way from the shaft, east and west in the scoriaceous bed, which is over 50 feet thick. It dips to the north, into the other strata at about 25°. The whole is not metalliferous, nor are the deposits of copper as regular as those in a vein, but the rock hitherto taken out is rich stamp work. Almost every piece shows spots of silver, in a native state. They are running 8 heads of stamps by a water wheel, and expect to add 4 more, making 12.

The great question concerning this deposit is, whether the metal extends throughout the mass or is collected near where it is cut by two veins. If it carries copper throughout its product must be immense. This belt crosses the Cliff, Phœnix, Meadow, Humboldt, Copper Falls, Eagle Harbor, and Native Copper Company grounds.

*Nebraska Mine.*—The Nebraska has sent down the past year *Thirty-five* tons of copper instead of twenty tons, as was erroneously given in several papers below. When we consider that this was taken out in the course of their openings, with very little taking down of the vein, it certainly looks quite favorable.

There are indications of a walled vein in the drift, though this can be more definitely determined after stoping up so as to expose the rock for a greater height. Still there is much at present in sight to show considerable regularity and a distinctly marked boundary to the copper-bearing rock.

*Ridge Mine.*—The Ridge Mine is now working about fifty men, and raised during the month of November about seven and a half tons of copper.

Their total product from January to December 1st, 1855, was fifty-six tons and seven hundred weight. On account of financial troubles they lost one entire month's labor, as far as raising copper was concerned.

Their monthly expenses are about $2,500, so that during the month of November these were paid by the copper raised. The ground when we visited the mine was looking quite well, and seems to improve as they sink. It is also much easier worked. A cross cutting from the first level was driven sixty feet at a cost of $11 per foot; whereas similar work at the 3d and 4th levels was done for half that sum. At the fourth level the cross cut is driven south 200 feet.

They have sunk two shafts to the depth of sixty fathoms. Clark shaft—the western—is sunk some thirty feet below that level, and they are now taking out considerable copper from that point by an underhand stope below the floor. The shafts at this level are not connected; but it is driven for 170 feet to the eastward from Clark shaft to the winze. The ground, also, is pretty much stoped away between this and the level above, and has proved quite productive of copper.

The fourth level has been opened for a distance of 515 feet—about 160 of which is to the east of Hanna shaft.

A remarkable and interesting geological feature is seen in this mine. A cross course bearing some copper, cuts the vein at the mouth of Clark shaft, and is observable at all the levels, until about 20 feet below the fourth it is intersected by Hanna shaft.

The surface improvements at the ridge are very good. They have in all eighteen buildings, with accomodations for 75 or 80 men.—12 head of stamps are now running, driven by a very good engine of 25 horse power. Their hoisting engine is of 40 horse power, and is placed between the two shafts. Their stuff is hauled up on trams laid down the shaft on the inclination of the vein—about 45°—which seems to answer the purpose well. And it is certain that an immense amount of friction is avoided by this plan, if there proves to be no difficulties in its practical operation. Where the vein is so flat it seems to us that its advantages are obvious.

The *Norwich* will arrange to work about fifty men,—half the force they intended. Of course they cannot be expected to take out half the copper *which they would* have done with a full force.

The *Windsor* suffers mostly from lack of machinery, as with it she would be already in condition for preparing a large amount of stamp work.

The *Trap Rock* was short of almost every thing. But we believe they have succeeded in making arrangements to do considerable work.

The *Forest* has abundance, and will take a high rank among the copper-producing mines.

The *National* is also well supplied.

The *Minnesota* has a complement of supplies, but parts of her new hoisting engine are wanting. As there are immense masses already uncovered, particularly in the south lode, it is clear that it will require the aid of their powerful machine to get the copper out of the mine.

The *Rockland and Flint Steel* have every thing necessary.

The *Nebraska* is very destitute, but will probably be able to keep a force sufficient to push on their openings.

The *Ridge* have their supplies.

Those mines working on tribute and the smaller ones adjacent, the *Adventure, Aztec, Merchant*, and *Evergreen Bluff*, have their supplies.

The *Toltec* has every thing essential.

The *What Cheer* and *Douglass Houghton* are not very deficient.

The *Fire Steel* has suspended for the present, and transferred their stock of supplies to the Douglass Houghton.—*Miner.*

### THE COPPER MINES OF TENNESSEE.

A correspondent of the *Union and American*, thus speaks of the eastern section of Tennessee:

The copper fields of Tennessee lie in the Eastern Division, and were but a few years ago entirely unknown. Their exploration and development are yet in their incipient state. Nevertheless, there have been shipped this year from all the mines 14,291 tons. It is estimated by the able and experienced President of the Hiwassee Mining Company, Samuel F. Tracy, of New York, that if they had a branch railroad from the mines to the East Tennessee and Georgia Railroad, the different Companies could have shipped 29,000 tons. The Hiwassee Company alone sold their ore and copper in New York for $150,000, but the cost of transportation was 65,000. Much of this enormous sum was paid for wagoning, and freight on the Oconee River, and boxing, which might have been saved by the proper railroad facilities. The copper ores of Tennessee are said to be exceedingly rich, averaging from 18 to 40 per cent.—the general average being 18 per cent. The English ores are said to yield an average of 8 per cent, Chili 20; the Cuban about 15 per cent. The world produces about 60,000,000 pounds of copper annually. Of this amount, in 1852, Great Britian and Ireland produces of ore and metal 28,820,000 pounds: Chili exports 18,000,000, pounds; and Cuba produces 8,000,000 pounds which she sends to England for smelting, being destitute of fuel.

Had East Tennessee railroad facilities, she could mine and export next year 30,000 tons of copper ore, which, even yielding 12 per cent. would amount to $2,000,000 if sold at the present prices in New York. Mr. Tracy calculates that if East Tennessee had railroad facilities commensurate with her ability to supply, such is the extensive and inexhaustible character of her copper fields, that she could produce one eighth as much as the whole world.

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### BALL'S CRUSHERS.

A correspondent thus writes to the Lake Superior Miner respecting this machinery:

You observe that conflicting accounts are given of the performance of Ball's crushing and washing machines. The crushers and washers were run but a few hours at a time, in all, I think something less than half a day.

Most of this time only one stamp head was in motion, because the number of washers hitherto set up, is not even sufficient to wash the stuff from one stamp. The rock crushed was stated to have been thirty-three tons. I saw a pile of rock which Mr. WREN, the mining captain, said was equal to half a ton, crushed in 19 minutes, by one head.

The mill had been put in motion by Mr. BALL at the request of Messrs. WILSON & BENNET, of the Huron and Isle Royal Mine, and was stopped as soon as the pile was exhausted. It was not a fair trial for the crushers, which could do better, with higher steam and on a larger pile of stuff. It could, I should say, very easily pulverize two tons an hour per head. The rock was from the so-called "ash bed," and not burned. The washers were not in motion for washing. What had been washed from the 33 tons previously stamped was cleaner and purer than any stamp work which I have seen on the lake—probably 95 per cent. I noticed, however, a waste of copper in the troughs below the mill. Mr. BALL explained this by saying that the washers were overcharged, and that it required more machinery to do the work for one stamp head. The mill has not been run since the 1st of November, and will lie still this winter.

It is said that BALL's contract requires two head to stamp 50 tons in 24 hours, and this may be done with *one*, running at the rate of 100 strokes per minute. It was run at 90 strokes per minute on the 1st inst. Pieces of the size of a brick, will enter the feed hole, and the stamp will crush any thing which enters. To explain the construction of the mill would require a large space and many drawings.

The stamp head and rod is of iron, together weighing about 2,500 pounds. It falls into a large mortar that rests upon metallic rubber springs, and is raised by a piston rod, which also throws it down by the force of steam. The stamp head covers about one fourth of the basin of the mortar, and makes a revolution or circuit around the mortar once in four strokes.

The whole contrivance, and the execution of the machinery, is ingenious and workmanlike. It is somewhat complicated, which will increase the chances of getting out of order, a point that requires a trial of at least a year to settle.

The steam is generated in two locomotive boilers, which are abundantly sufficient to run both heads and the washers attached. The number of washers now in the building I think is 20, and it is calculated for four times the present number.

Mr. BALL states that it will reqnire one engineer, one fireman, one feeder at the stamp head, and one man to attend the washers, making four for each shift. A man will be necessary (and probably two) to bring the stuff from the pile to the hopper.

You see, therefore, in present circumstances, two different persons might very honestly bring you different accounts of the success and value of the machine. It has not been fairly tried. If the machinery proves to be permanent, and does not waste too much time, and consume too much money in repairs, the stamping can be done cheaper than in our present mills, and the rock will be better pulverized. The great field for improvement is in washing, and here Mr. BALL has the utmost confidence. The mining interest owes him much, and also the directors of the Copper Falls Mining Co., for making the trial. If it accomplishes half what Mr. BALL anticipates as a washing apparatus, it will be a saving upon our present system.

THE

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VOL. VI.—MARCH, 1856.—No. III.

## ART. 1.—PROCESSES FOR DISTILLATION OF THE PRODUCTS OF COAL.*—BY C. B. MANSFIELD.

THE first part of my invention relates to the manufacture of certain spirituous substances and oils, and consists in treating tars and bituminous substances, or the oils obtained from them, so that the most volatile, oily, or spirituous substances which are contained in them are separated, viz., such as are so volatile that a current of air passed through them at ordinary atmospheric temperatures, will take up so much of their vapor as to burn with a white flame; and this part of the invention also relates to separating from each other certain oils and spirituous substances, which are contained in the tar or oily matter, distilled from any of the different varieties of mineral coal, when coal is distilled either alone or mixed with other substances, either in the process for making illuminating gas, or in any processes in which coal is submitted to destructive distillation, which oils and spirituous substances have not hitherto been obtained separate from coal-tar and from each other. This part of the invention also relates to the conversion of some of the oils and spirituous substances separated from coal-tar into fragrant oil by the action of nitric acid.

Since that part of my invention which is applicable to bituminous oils and tars generally is applicable particularly to coal-tar, I will first describe its application to coal-tar, and will then show its general application to other tars and bituminous oils.

In order that my invention may be most fully understood, I will first state briefly the nature of the substances usually prepared from coal tar by distillation, and then I will explain what are the peculiar properties of the substances which I obtain, and

* Specification of the Patent granted to CHARLES BLACHFORD MANSFIELD, of Clare Hall, in the University of Cambridge, Esquire, for An Improvement in the Manufacture and Purification of Spirituous Substances, and Oils applicable to the Purposes of Artificial Light and Various Useful Arts.

then I will describe the means pursued by me in order to obtain substances possessing such properties.

It must be understood that coal-tar is not a substance of invariably similar constitution, but that though its constituents are generally the same, their proportions vary in different samples, and the causes of the variations therein are not yet understood.

In the distillation of coal-tar the products which are generally recognized as distinct, and are separated from each other, are ammoniacal water, oil heavier than water, which is usually called dead oil, and oil lighter than water. The light oil (of which the first and the last portions are sometimes received separately, in which case the first portion only is called naphtha), comes over at first accompanied more or less with the water, and afterwards the heavy or dead oil which is separated from the light oil by changing the receiver when the distillate begins to sink in water. Some samples of tar also yield a large quantity of naphthaline, an oil which is solid at ordinary temperatures.

In distilling tar which contains much naphthaline, the last portions of light oil and the first portions of heavy oil will deposit solid matter in cooling. In some tar the naphthaline, together with paranaphthaline, another solid oil, exists in such quantity, that a large proportion of the heavy oil solidifies in cooling. Other samples of tar contain so little naphthaline that no solid matter is deposited, except by the last portions of the oil which are distilled over at the highest temperatures, to which the retorts are generally exposed. The distillation of coal-tar is usually stopped when the oil has ceased to run freely fluid, and a yellow semi-solid matter appears. The light oil, or the naphtha alone, is usually rectified from some heavy oil which it contains by distillation, and is more or less purified by treatment with acid, which is usually concentrated sulphuric acid, if the oil be required colorless, and then forms the rectified coal naphtha of commerce; the less volatile part of the light oil, if separated, and the heavy or dead oil, is not rectified usually, but is applied to coarse purposes in which a pure article is not required.

It is known to chemists that the crude oils of coal-tar contain a quantity of oily matters, some of which are acid, and have received names such as carbolic and rosolic acids and others, and some alkaline, which have been called aniline, picoline, pyrrol, &c.; and besides these an oil which, by exposure to the air, becomes converted into a brown resinous matter. The object of the processes of purification of the oils has been to remove these substances. The nature and properties of the neutral oils, some of which constitute the rectified coal naphtha, have not hitherto been known except that they are hydro-carbons, that is, composed of hydrogen and carbon alone, and that the naphtha has been supposed to be a mixture of several such bodies.

*I* have thought it necessary to state the above facts in order

more readily and clearly to define the nature of this part of my invention, which consists of manufacturing certain hydro-carbons and other substances from tar.

In speaking of temperatures, I at all times refer to the centigrade thermometrical scale (known also as that of Celsius), in which the freezing point of water is marked, 0 degs., and the boiling point of water, 100 degs.

If the unrectified light oil of commerce be distilled without water, it generally commences to boil at about 100 deg., and continues to distil till the temperature of the boiling fluid reaches 200 degs., or thereabouts; the last portions often become solid as they cool. The rectified naphtha of commerce of the best sort generally commences to boil at about 90 degs., and a portion of it (which seldom exceeds one-eighth of the entire quantity) distils over before the temperature in the retort reaches 100 degs.; and the temperature gradually rises as the distillation continues till it reaches about 160 degs., when the retort becomes generally dry. The rectified naphtha does not solidify or deposit crystals on being submitted to a temperature of 20 degs. (20 degs. below 0 degs.), but some samples of the crude naphtha, if so treated, will deposit crystals or solid matters, which consist of naphthaline, and if separated will be found to remain solid at about 20 degs., and when fused to boil at about, or somewhere above 200 degs. I mention these properties to distinguish rectified naphtha from the spirituous substances which I manufacture from naphtha or tar. And here I would state that the supposition which prevails among naphtha makers, that "*the strength*" of coal naphtha is determinable by its specific gravity in the same way as that of alcoholic or pyroxylic spirits, is entirely fallacious. In the first place, strength as applied to these spirits means relative freedom from water, with which they will mix in all proportions, and the specific gravity and volatility of the mixture are respectively in direct and inverse ratio to the amount of water in the mixture; so that the specific gravity is a true index of the strength of such spirits, but the term "*strength*" can have no corresponding meaning as applied to coal naphtha or spirituous hydro-carbons, which are not capable of dilution with water. In the second place, the specific gravity is no index of the volatility of the naphtha, or of the quantity of the more volatile spirituous substances which it contains beyond certain limits. If the rectified naphtha has a specific gravity above ·875, taking water to be one, it may be considered as a sign that it still contains naphthaline or some other oil, which boils at a temperature above 200 degs., or some of the impurities which are removable by acids, and so far the specific gravity is a test of the volatility of the naphtha. But the neutral oils and spirituous substances which compose the pure naphtha (that is, when consisting only of hydrocarbons) are all nearly of the same specific gravity, viz., from

·85 to ·87, and in practice the specific gravity of the naphtha is rarely reduced so low as ·86; and in the state of purity in which the spirituous substances are obtained by rectification sufficient for ordinary purposes, I have found the most volatile of them have a greater specific gravity than some of the less volatile, so that the specific gravity is not a true test of the volatility of naphtha; and I state this lest it should be supposed that the spirituous substances which I produce from coal-tar or coal-naphtha are not different from, or not more volatile than ordinary naphtha, because the specific gravity of the spirituous substances manufactured by me may be the same as or even greater than that of ordinary naphtha.

I believe the only perfect test of the relative volatility of such spirituous substances, oils or naphthas, is by comparison of their boiling points, by which I mean the numbers marked by the index of a thermometer, when the sensitive part of such thermometer is immersed in the fluids, whose volatility is required to be known, the fluids being at the time in active ebullition. The boiling point in such matters is never constant unless the fluids be absolutely pure, and such purity is not easy to be attained in practice in the separation of fluids of different volatility when dissolved in each other, as is the case with the oils and spirituous substances in coal-naphtha, and it is found that the boiling point will continually rise as the fluid boils away into vapor. The points to be particularly noted in so ascertaining the volatility of such fluid are, first, the point at which ebullition commences; secondly, the points about which the largest quantity boils off; and, thirdly, that at which the whole has volatilized; and this test is most conveniently applied in a small glass retort with a tubule closed by a cork through which a glass mercurial thermometer passes, the bulb of such thermometer being placed below the surface of the fluid which is to be maintained in ebullition. The volatility of hydro-carbons may also be roughly estimated in some cases by placing a few ounces of the fluid in a bottle closed by a cork, through which two tubes of about one-eighth of an inch bore pass, one terminating below, and the other above, the surface of the fluid, on a stream of air being forced through these tubes, entering by the former tube and escaping by the latter, and a lighted match being applied to the orifice of the latter, by observing the magnitude and the proportion of white light in the flame, if any, which appears at the mouth of the tube; and this apparatus I shall call a "test bottle," when I subsequently refer to it. And in some cases the non-volatility of hydro-carbons may be ascertained by their non-inflammability at the surface on approach of a lighted match.

I will now proceed to state what are the spirituous substances and oils which I have found in coal-tar, and which I also separate more or less from each other, or manufacture more or less mixed

with each other, or with other substances by the methods hereafter described:—

First, I have obtained a spirituous substance which is extremely volatile, which boils when pure at about 60 degs. or 65 degs., does not solidify at 20 degs., and has a powerful sulphurous or alliaceous smell. This I call Alliole.

Secondly, a spirituous substance which is less volatile than the last, which boils when pure at about 80 degs., and solidifies at 0 degs., being the only one of the spirituous substances that can be solidified by a temperature above 20 degs., having a smell resembling almonds, which I call Benzole.

Thirdly, a spirituous substance which boils at about 110 degs., and does not solidify at 20 degs., which I call Toluole.

Fourthly, a less spirituous and rather oily fluid which boils at about 140 degs., which I call Cumole.

Fifthly, an oil which boils at 170 degs., which I call Cymole.

The aforesaid spirituous substances and oils are obtained or manufactured chiefly from "*light oil*," but the Cymole is found also in "*heavy oil;*" and,

Sixthly, I have found in the heavy or dead oil, an oil which, when pure, boils at about 240 degs., and is of specific gravity ·900, which I call Mortuole.*

I now proceed to state how these substances may be obtained, first remarking that I shall describe other properties of some of these spirituous substances and oils when treating of the preparation of each.

(To be continued.)

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## Art. II.—ORIGIN OF PROTO-CARBONATE OF IRON IN COAL MEASURES.†

Prof. Wm. B. Rogers exhibited specimens of Iron Ore and of Shale and Shaly Sandstone, more or less impregnated with Proto-carbonate of Iron, from the Bituminous-Coal region of the Trans-Alleghany basin, and called the attention of the Society to what he regarded as the most probable and simple theory of the origin and accumulation of the Proto-carbonate of Iron in Coal Measures generally.

This compound of iron, as we know, where mined in the coal measures, presents itself in courses of lenticular nodules and interrupted plates, usually included in carbonaceous shales, and in the fire-clays which underlie the seams of coal, and in such cases

* For the process by which to manufacture paraffine and paraffine oil—See Mining Magazine, vol. 5, No. 5, October, 1855.

† Boston Society of Natural History.

it often forms a heavy ore, containing but little earthy or organic matter, mixed with the proto-carbonate. But it is also frequently met with in a *diffused condition*, pervading thick strata of shale and shaly sandstone, and causing those rocks to present in their different layers, all the gradations of composition from a poor argillaceous and sandy ore, to beds of sandstone and shale, with little more than a trace of the ferruginous compound.

On comparing the different subdivisions of a system of coal measures, we may remark certain general conditions connected with the abundance, or with the comparative absence of the Proto-carbonate in the strata.

One of these is seen in the fact that the lenticular ores and strata, impregnated with proto-carbonate of Iron, are in a great degree restricted to such divisions of the carboniferous rocks as include beds of coal, or are otherwise heavily charged with carbonaceous matter. This is well shown on comparing together the four sub-divisions of the carboniferous rocks of the great Trans-Alleghany coal region, as classified under the head of the Seral coal series of the Pennsylvania and Virginia Geology. In the first of these, designated as the Older coal measures, the proto-carbonate is found in large amount, both in the shape of layers and lenticular ore, and diffused through the substance of the shaly strata. In the next division above, distinguished as the Older barren shales, and which, as the name implies, is comparatively devoid of carbonaceous matter, much less of the proto-carbonate is met with. In the third group, that of the Newer coal measures, the ore again abounds, and in the uppermost division or Newer barren shales, it has a second time almost disappeared.

The connection between the development of the proto-carbonate in the strata, and the presence, either now or formerly, of a large amount of carbonaceous or vegetable matter, becomes even more striking on a detailed examination of particular heads. Thus, in the coarse sandstones of the coal measures which are comparatively destitute of vegetable remains, we find little admixture of the proto-carbonate. On the other hand, the fine grained flaggy argillaceous sandstones, which are often crowded with the impressions and carbonized remains of plants, are at the same time more or less impregnated with this ferruginous compound. So, again, the soft argillaceous shales, in the midst of which the lenticular ore so frequently presents itself, show, by their dark color and included impressions of plants, as well as by actual analysis, that they are richly imbued with vegetable matter. Nor do the nearly white fire-clays, which in many cases enclose thick courses of the lenticular ore, form any exception to this law. For, although in their present state they contain little or no carbonaceous matter, the marks of innumerable roots of Stigmaria and parts of other plants which everywhere penetrate

the mass, show that at one time they must have been crowded with vegetable remains.

A further and yet more striking proof of the influence which the contiguous vegetable matter has had in the formation of the proto-carbonate, is seen in the fact that the most productive layers of the ore are commonly met with quite near to the beds of coal, and that frequently crowds of the nodules are found in the carbonaceous shales or partings, which lie in the midst of the seam itself.

While the strata, including the proto-carbonate, are thus distinguished by the admixture of more or less carbonaceous matter, they are *also remarkable for seldom exhibiting a distinctly red tint.* Presenting, where not weathered, various shades of greenish gray and olive, and bluish black; they only become brown or red where, by exposure to air, the proto-carbonate has been converted into the sesquioxide of iron. On the other hand, those divisions of the coal measures which have been but slightly charged with vegetable matter, as for example, the barren shales of the Seral Coal Rocks, before alluded to, contain much red material, both in distinct strata and mottling the general mass, and are throughout more or less impregnated with the sesquioxide.

A like general law, as to color, would seem to apply to the other great groups of sedimentary rocks which include, in particular beds, accumulations of vegetable or other organic exuviæ. Thus, in the New and Old red sandstone formations, which generally include so large a proportion of sediment, colored by the red oxide of iron, organic remains are of comparatively rare occurrence, and when present, are met with almost exclusively in the gray and olive, and dark-colored strata, which are interpolated in certain parts of the great masses of the red material. This relation is beautifully shown in the middle secondary rocks of the Atlantic slope, which extend in a prolonged belt from the Connecticut Valley into the State of South Carolina. In the strata of *red* sandstone and shale, which form the chief part of the mass, vegetable or animal exuviæ are almost entirely absent. But the remains of fish and impressions of carbonized parts of plants occurring in this group of deposits, are found imbedded in layers of greenish and olive sandstones, and dark bituminous shales. So in the southern parts of the belts in Virginia and North Carolina, where these rocks include seams of coal and extensive beds of sandstone and shale, containing the remains of plants, the usual red color is found to give place to the gray, olive and dark tints of the Old coal measures, and layers of proto-carbonate of iron show themselves in the vicinity of the coal seams.

Taken in mass, the red and mottled strata of the unproductive coal measures, or of the other groups of red rocks above alluded to, would no doubt be found to contain, in an equal thickness, as large an amount of iron as the coal-bearing strata, which include

the layers of carbonate, the difference being, that in the former case the metal remains for the most part diffused through the rocks as a sesquioxide, while in the latter, having assumed the condition of proto-carbonate, it has to some extent been concentrated in particular layers or strata. According to a rough estimate of the amount of carbonate ore included in the lower coal measures of the Laurel Hill region of Virginia and Pennsylvania, derived from a detailed examination of the ores and associated strata at several points, it may be safely assumed that the equivalent of sesquioxide of iron would not amount to one third of one per cent. on the whole mass of this portion of the coal measures, and a proportion not exceeding this is deducible from the measured sections of ore and accompanying rocks in the carboniferous strata of other tracts subjected to a similar calculation.

But even allowing a quantity three times as great as this to cover the diffused carbonate, and the oxide in some cases mingled with it, we should have only about one per cent. to represent the proportion of ferruginous matter in the entire mass, an amount undoubtedly much less than what exists in many of the strata of red and purple shales and shaly sandstones of the carboniferous series, or of the groups of red rocks geologically above or beneath it.

In attempting to explain the origin of the proto-carbonate under the conditions above described, it is important to keep in view the fact of the diffusion of this compound through many of the strata as a general constituent, and the frequent preservation, even in layers of the ore, of the lamination of the contiguous rock. The supposition of its being a chemical deposit formed from springs charged with carbonic acid, and holding proto-carbonate in solution, is evidently inconsistent with these conditions, and not less so with the fact of the great horizontal extension of individual beds of ore and impregnated shaly rocks.

In view of these various considerations it may be concluded—

First. That throughout the coal measures and other groups of rocks above mentioned, as well as in the portions containing coal and diffused vegetable and animal matter as in the barren parts, the original sediment was more or less charged with sesquioxide of iron, and

Second. That this sesquioxide, in the presence of the changing vegetable matter with which certain of the strata abounded, was converted into proto-carbonate, which remained in part diffused through these beds, or by process of filtration and segregation, was accumulated in particular layers.

It is well known that during the slow chemical changes by which vegetable matter, enclosed in moist earth, is converted into lignite or coal, both light carburetted hydrogen and carbonic acid are evolved, and that these gases are even eliminated from coal seams and their adjoining carbonaceous strata. The reducing

agency of the carbon and hydrogen, as they separate in their nascent state from the organic matter, is capable, as we know, of converting certain sulphates into sulphurets, and even more readily of transforming the sesquioxide of iron into protoxide. The latter change would doubtless be favored by the affinity of the carbonic acid present in the mass, for the protoxide, as formed, and in this way the sesquioxide would be entirely converted into the proto-carbonate of iron.

Conceiving a like process to have operated on a large scale in the coal measures or other strata, containing, when deposited, a mixture of sesquioxide of iron and organic matter, we have a simple explanation of the general conversion of this oxide into carbonate, and of the loss of the reddish coloring in which these materials more or less participated. As these actions must be supposed to have commenced in each stratum as soon as the organic matter contained in it began to suffer chemical change, we may conclude that the formation of the proto-carbonate was already far advanced in the earlier strata when only beginning in those deposited at a later period. Each layer of vegetable matter, as it was transformed into coal, would not fail to impregnate the adjoining beds of shale and sandstone with the proto-carbonate, and thus the development of this compound was, as it were, coeval with that of the coal.

The gathering of the diffused proto-carbonate into bands and courses of ore, began no doubt as soon as the production of this compound had made some progress, but it probably continued until long after the completion of the chemical changes above described, and, indeed, it is possible that in some strata it is not yet entirely finished. In this process, which finds a simple explanation in *the combined action of infiltration and the segregating force*, it can hardly be questioned that *the carbonic acid*, pervading the mass of sediment, acted *a very important part*. The large amount of this gas evolved from the beds of vegetable matter, undergoing change, would impart to the water of the adjoining strata the power of dissolving the diffused proto-carbonate, which being then carried by infiltration through the more porous beds, would accumulate above and within the close argillaceous or shaly layers, forming, in some cases, bands of rock ore, in others, courses of nodular and plate ores. Of these, the former would seem to have resulted from the accumulation by *gravity* of the dissolved carbonate in the substance of sandy shales, near the upper limit of the more impervious beds, while we may regard the latter as having been collected in all directions from the general charge of proto-carbonate accumulated in the argillaceous mass, its mobility in the dissolved condition greatly aiding the gathering process of the *segregating force*.

Dr. C. T. Jackson made some remarks upon this subject, a copy of which has been promised the Society for publication.

Dr. A. A. Hayes remarked that he had been much interested in the theoretical considerations presented by Prof. Rogers. He had long been aware that the conditions, belonging to deposits of proto-carbonate of iron in the coal measures, are such, as to forbid the supposition that the compound had been deposited from waters, holding the carbonate of iron in solution. The view presented, which refers the production of the carbonate, from the peroxide, by the reducing action of organic matter undergoing changes in contact with it, harmonizes with a mass of chemical facts and observations, already accumulated. The native hydrated peroxides of iron can be thus reduced to protoxide, and in fact converted into proto-carbonate of iron, in the laboratory, by the aid of decomposing vegetable matter. In observing this change it is always found that the reducing action on the peroxide, commences at the time that the first steps in the decay of the organic matter are observed. Carbonic acid gas, with carburetted hydrogen gas, appears at a later stage; the protoxide of iron formed, being insufficient in quantity to combine with all the carbonic acid which is produced. It is an essential condition in this change that water, or moisture, is present; as the organic decomposition —a kind of putrefaction,—would not otherwise take place. It is proper in this connection to state the fact, that the ferruginous springs of this country rarely contain carbonate of iron dissolved. The iron salt which is present is a *crenate*, originating from the decomposition of organic matter, in contact with ferruginous earth. The crenate of iron exists only as a proto salt; it is soluble in water, and when brought in contact with air, hydrate of peroxide of iron falls, usually containing some humus, or coaly matter, resulting from the decomposition of the crenic acid. It is not probable that the crenate can produce the carbonate of iron, if oxygen is present; but when protected from oxidation, and especially in presence of an excess of carbonic acid, the crenate *may* form a proto-carbonate of iron, as the crenate of lime, even in the atmosphere, forms carbonate of lime.

In referring the production of carbonate of iron deposits in strata, to the solvent action of carbonic acid dissolved in mineral waters, any theory should point out the source from whence the protoxide of iron is taken, to form the dissolved carbonate as protoxide of iron does not naturally exist. If a previous reduction of other oxides of iron, by organic matter, is necessary to insure this solution, it will probably be found that crenic acid, instead of carbonic acid, is the solvent.

The explanation, as given by Prof. Rogers, becomes, therefore, not only the simpler view—and strictly accordant with known facts—but it seems to be necessary, as a basis for the theory generally received.

There is a point of geological interest, in connection with the manner in which the proto-carbonate of iron is included in the

coal series, and often in contact with beds of coal. This compound, as before stated, is a hydrate compound, and its varieties generally lose their carbonic acid and become peroxide by a moderate elevation of temperature; its presence, therefore, in contact with alternating beds of coal, may be considered as indicating that such beds have not been subjected to heat above the temperature at which the carbonate is decomposed.

Prof. Jeffries Wyman stated that, a year or two since, in the Ohio River, opposite Cannelton, there was noticed a sudden commotion and explosion, followed by a considerable ebullition of the water for some time, so that boats avoided the spot. Immediately afterwards there was found a peculiar substance, light and porous, somewhat resembling pumice stone, floating around in the neighborhood. Specimens of this substance were presented by Prof. Wyman, and placed in the hands of Dr. Hayes, for examination.

Dr. C. T. Jackson observed that the material bore resemblance to slag from iron furnaces. On trial, it was found still to float upon water.

Prof. Jeffries Wyman exhibited some impressions in clay, of hail caught during a recent storm. These impressions differed from those of rain, all of them being quite small and considerably deeper than impressions of rain drops of the same diameter. Around several of the marks was observed a radiated appearance, caused by a crystallization of the moisture of the clay by the contact of the hailstone, the clay itself being at about the temperature of freezing water.

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ART III.—VISIT TO THE LAKE SUPERIOR REGION, IN 1854.*—By Prof. E. RIVOT, of the French School of Mines. No. 3.

## GENERAL ARRANGEMENT OF THE STRATA.

THE chart of Messrs. Foster and Whitney extends on the south to the borders of Lake Michigan, on the east beyond the Sault Ste. Marie: on the north, it shows the composition of the series which form the English coast; and on the west it terminates at the boundary of the State of Wisconsin. The zone which separates the two lakes, Michigan and Superior, presents the upper part of the series which existed throughout the whole surface, now occupied by the great lake, before the upheavals and derangements which have produced the actual face of the country.

It is formed in part of magnesian limestone, belonging to the

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lower Silurian period, and resting upon white and red sandstone. On the south shore of the Lake Superior, the sandstone appears by itself in horizontal beds, presenting, at many points, very high bluffs or banks with alternate beds of different colors. The most remarkable point is situated near Grand Island. Its picturesque aspect has obtained for it the name of the "Pictured rocks," which is already well known in America.

The granite and the metamorphic rocks compose the principal part of the east side, and two extensive masses, one north of the lake, very near the shore, and the other south of Point Keweenaw, from Chocolate river to Wisconsin.

The granite and metamorphic rocks on the east in Canada, are at present but little known; it is a portion of the mass at the north, of which only that part in the neighborhood of the lake has been explored. So far as regards the mass on the south, it has been examined throughout, and its limits are exactly marked on the chart.

Its general direction is N. 70° E.—sensibly parallel to the mountain chain of Isle Royale and to the granite mass of the north, it presents a series of conical mountains, elevated 300 to 400 metres above the level of the lake, and separated by valleys of shallow depth. It is covered, very generally, by rocks, which the American geologists consider as metamorphic, by gneiss, mica, schist, quartzose, &c.

Considerable masses of oxide of iron are enclosed in these series, and they seem to continue even to the granite. They have been worked many years with a degree of activity, and some furnaces have been erected a short distance from Chocolate and Carp rivers.

The granite is encircled by sandstone, which is elevated a certain height on all sides, although at small angle, and appears to have been broken and upheaved by the granite.

North of Isle Royale, in Canada, the granite forms mountains 500 and 600 metres in height above the level of the lake, and has produced in the upheaved strata much greater disturbance than is observed on the south side.

Isle Royale is composed of trap, conglomerate and sandstone, arranged in thick beds, and in layers strictly parallel, running N 65° E. S. 65° W. and dipping to the south at the very small angle of 8° to 10° with the horizon.

The American side comprises the Point of Keweenaw, the region around Portage lake, and the Ontonagon district, embracing trap, conglomerate and sandstone, equally in beds parallel to each other, and dipping to the north and north-west at an angle varying from 25° to 55°.

Between the trap which shows itself in high mountains from Keweenaw Point even into Wisconsin and the granitic mass on the south, there exists a vast sandstone formation extending from the

border of the lake on the east to the trap on the west. In the east the sandstone is found in beds apparently horizontal, but it dips at different degrees of inclination, where it comes in contact with the trap, granite and metamorphic rocks. The magnesian limestone, west of the bay of Keweenaw, demonstrates the identity of the sandstone of Keweenaw Point with that of the southern shore.

The alluvium containing pebbles, clay and sand, covers by far the greater portion of the country. It contains boulders which demand, for their formation a period which has hardly been a recent one.

In short, the Island of Michipicoten, on the east, is almost entirely composed of trap, analogous to that at Keweenaw Point, and in which native copper and veins of copper ore are found.

I shall now proceed to speak in detail of those parts of the country which are the best explored, and are the most important in consequence of their immense richness in copper; these are Keweenaw Point, Ontonagon, and Isle Royale.

## KEWEENAW POINT.

The name Keweenaw Point is applied to that tongue of land which projects from the southern side of the lake, forming a curve, the convex side of which faces the north. It is almost separated from the main land by Portage Lake, the position of which between the foot of Keweenaw Bay and the north coast, indicates a transverse fracture of all the series. The geological constitution is the same on both sides of this narrow lake, and the distinctions which are found between Keweenaw Point and Ontonagon do not appear to have any relation to this purely geographical separation.

The nature of the strata, of which Keweenaw Point is composed towards its eastern extremity, can be more plainly observed than in other parts of the country, in consequence of the almost entire absence of alluvium, which can be ascribed to a partial denudation.

Two chains of mountains which are parallel and at a short distance from each other, and which are composed of trap in a more or less crystalline state, point out the central axis of the Point. The most important, in a geological aspect, are the Bohemian Mountains, which extend without interruption from the eastern extremity to Portage Lake, and thence west beyond Ontonagon. It is in this course that the upheaval of all the strata must have been made.

The other chain, which is more northerly, runs parallel with the shore, from the extremity of the Point to the Albion mine; it is only a belt of trap formation, and any interest which it possesses is purely local. At Point Keweenaw only it becomes most noted by the miners; being in a small degree metalliferous, it separates the two zones of trap in which are the richest copper veins.

South of the Bohemian mountains, the sandstone overlays the trap, and dips to the south at a large angle, which diminishes more and more, as the distance from the trap diminishes.

On the north, we meet at first with belts of trap dipping to the north and north-west, afterwards with beds of conglomerate, trap and sandstone, and finally sandstones similar to those at the north, and presenting like them an inclination which decreases as the distance from the axis of elevation increases.

The principal chain of mountains is composed of crystalline trap, porphyry and sienite, arranged in belts hardly defined, and which appear parallel to the general direction of all the strata. As this disposition is less marked than in other parts of the formation, the rock is often designated by the term "unbedded trap" (trap non-stratific).

The southern slope dips towards the south and south and west, at an angle which varies considerably, but which is generally comprised between 35° and 55°; the northern slope presents an opposite inclination to the north and north-west, at an angle of 30° to 35°. Further to the west the inclination is greater, and in the Ontonagon region it is 55°.

The highest points of the Bohemian mountains are not more than 290 metres above the level of the lake, but the valleys are shallow, and this chain forms the division line between them, from Lake La Belle to Portage Lake.

On the south the trap is separated from the sandstone by a bed of chlorite, fifty metres in thickness, which contains many fissures and is partly altered, containing feldspar, oxide of iron, and hornblende; in some parts it changes to amygdaloid trap, and contains irregular veins which have been explored by many companies with very little profit.

On the east the crystalline trap does not extend to the extremity of the point; it is replaced by compact trap, in the midst of which rises Mt. Houghton.

On the north of the Bohemian mountains the surface consists of a very irregular longitudinal valley, which is for the most part covered by alluvium; near the Cliff mine the valley is broad, but becomes very narrow towards the western extremity of the point. In all parts of it where it has been practicable to inspect the rock, it is found to consist of compact, granulated or amygdaloidal trap, forming thick beds, which are often separated by strata of sandstone conglomerate. Only the district north of Eagle and Little Montreal rivers has been well explored; the mines of native copper, worked at the foot of the second chain of mountains, have caused this belt of trap to be designated as the south metalliferous zone. Its length is about 2500 metres, and its thickness 1200 to 1300 metres.

The valley on the north of the Bohemian mountains is bounded by very elevated bluffs of trap of a crystalline texture, which

is called greenstone. This name is very inappropriate, since all the varieties of trap are colored green, which is of different degrees of intensity. I shall, however, adopt the term in order to avoid any confusion between this rock and the crystalline trap and porphyry of the south.

The greenstone forms a chain of mountains 180 to 200 metres in height above the level of the lake, and is composed of vast beds parallel to each other and to those of the south metalliferous zone. The course is nearly east and west around Copper Harbor; at the extremity of Keweenaw Point it turns a little southerly; and towards the west it gradually becomes north-east and south-west. The narrow and accidental table-land which marks the summit, is broken only by the deep valley in which flows the Eagle river on its course to the lake. The valley of Eagle river, as well as the curve of the belts of all the strata, indicate a transverse fracture, less distinct, however, than that of Portage Lake.

The inclination of the beds of greenstone is towards the north and north-east, from 25° to 30°, and the line of inclination is evidently normal to the shore. On the south the greenstone is separated from the amygdaloid trap upon which it reposes, by a bed of conglomerate and a feldspathic belt containing native copper: on the north it is covered by parallel beds of compact amygdaloid and granular trap which compose the north metalliferous zone. The horizontal distance between the conglomerate and the compact trap is very variable, being from 400 to 700 metres, and such that it is difficult to determine the actual thickness of the greenstone; it can be estimated approximately at 300 metres.

The veins explored on Keweenaw Point traverse a rock of a questionable crystalline texture, but they do not contain sufficient copper to be worked; they become richer in the belt of trap which covers the greenstone, and is composed, like that on the south, of varieties of compact, amygdaloid, and granular, forming powerful beds, often separated by layers of sandstone or conglomerate.

On the eastern portion of Point Keweenaw, the metalliferous zone of the north is well exposed; it presents undulating hills, generally parallel to the shore, and of a height always less than that of the mountains of greenstone; their bearing towards the lake is a trifle less than that of the belts of the strata, 25° to 30°; their inclination towards the south is greater, and almost perpendicular to the bearing towards the north. On the west, the trap is in part covered by alluvium, but it is easy to perceive that the deposit is the same as that on the east.

The horizontal extent of the trap north of the greenstone is between 1700 and 2400 metres, and consequently the total thickness of the different beds is from 1100 to 1200 metres.

On the north of this second metalliferous zone, alternate beds of conglomerate, sandstone, and compact and amygdaloid trap are found. All the beds are parallel to the benches of trap, and dip towards the north, and afterwards towards the north-west, under the same angle of 25° to 30°.

Messrs. Foster and Whitney state in their report, that they observed the sandstone and conglomerate to be very much altered at the point of contact with the trap, but only when the latter rests upon the former. The same alteration is not manifest at the points where the conglomerate and the sandstone repose on the trap; hence, these geologists have inferred that the trap was in a state of fusion when it reached the sedimentary rocks, whilst however, the latter were not deposited upon the trap until it had become completely cold.

In addition to these alterations, there are on the north, some very thick beds of reddish conglomerate, containing many seams of sandstone. This rock is likewise nearly parallel to the trap, and presents the same inclination of 25° to 30° towards the north and north-west; its thickness is considerable; for in estimating its horizontal extent perpendicularly to its course, we do not find less than from 1800 to 2000 metres of conglomerate, which raises to 1000 and even to 1100 metres the thickness of this formation.

The grand zone of conglomerate is covered by very powerful beds of amygdaloid trap, separated by very thin layers of sandstone, and preserving the most complete parallelism with the lower formations. It is slightly elevated above the level of the lake, and forms very dangerous rocks on the coast from Agate Harbor to Cat Harbor. The thickness of this amygdaloid belt is less than 250 metres, and its horizontal extent cannot be established, except between Copper Harbor and Agate Harbor; it does not exceed 450 metres.

A second zone of conglomerate is superincumbent upon the amygdaloid trap, but it does not appear upon the borders of the lake, except from the extremity of the Point to the bay of Agate. It is elevated only a few metres above the level of the lake, forming an irregular cliff, destitute of vegetation. The ports of Copper Harbor, Agate Harbor, Eagle Harbor, and Cat Harbor, are in part conglomerate and in part amygdaloid trap.

At the west of Cat Harbor the alluvium covers the shore and the greater part of the country, and prevents a distinct observation of the succession of the strata, except towards the west. North of the great metalliferous zone we distinguish only a feeble thickness of conglomerate, but some hills of red sandstone, of feldspathic reddish sandstone, and white sandstone. The beds of sandstone are parallel to the belts of trap, and the inclination is always towards the north-west, but the angle gradually diminishes. Around Portage Lake, the shore is more than 4000 metres

from the trap, and the sandstone appears to dip at an angle of 20° to 22° only. The decrease of the angle of inclination is more distinct on the south-west of the Portage, even into the Ontonagon region.

(To be continued.)

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ART. IV.—THE MINING OF COAL,* &c., &c. By A. T. PONSON. No. 8.

Translated from the French, for the Mining Magazine.

18. *Composition of Coal Seams.*

IT is rarely that the seams form a compact and uniform mass. They are the result, chiefly, of superincumbent layers, which the miners of Arnin and Charleroi call *sillons*. These are separated from each other, sometimes by a simple fissure parallel to the plane of stratification, sometimes by seams of layers or clay slate of variable thickness, often carbonized, or bituminous, but usually soft and friable. These layers are called, according to their location *haverie*, *houage*, *nerf* or *gore*. When they have very considerable thickness they take the name of *barre*.

The line of separation between a seam and its wall is sometimes imperceptible; the two surfaces adhere in such a manner that where the breaking down is done, some layers remain suspended in the roof; but, if this is brittle, the coal falls, bringing down with it a part of the stratum to which it is attached. When the line of separation is plainly indicated and defined, the coal is easily detached from the enclosing rock. The same is true when ther, intervenes a slaty layer, formed of bituminous clay; these stratifications which may occur in the foot wall or roof, are the *salbandes* and *lisières* of seams.

The principal features of the composition of the latter are the following:

A thin seam may be formed of a single layer; if its texture is solid, it will yield blocks which will be detached in single pieces. The Liege miner then says the seam is one of a single *cachet*.

It can be composed of two or more layers, incumbent one upon another without the intervention of foreign matters. If the coal is compact and the thickness of the seam uniform, the blocks will diminish in volume according as the layers are increased, and consequently will be less in thickness.

If it is slaty, leafy, or traversed by numerous fissures, it will yield only fine coal. If one layer is compact and the next brittle, the seam will yield at the same time coarse and fine coal in proportion to the thickness of each stratification.

* Continued from page 52, vol. 6.

A layer may be separated from the next one by a slaty roof or intervention; when these are numerous or quite thick, it is extremely unfavorable. For if in extracting the coal we do not use care and great pains, we obtain it only in a very impure state, and it is not then possible to deliver it in marketable order but after great expense for labor.

The evil becomes far more serious when the roof and the coal itself are leaflets (thin like leaves), and fall in very slender pieces or parcels. But when the leaflets of slate are only one or two decimetres in thickness, when these interstratifications are few in number, and, especially when there is only one either at the roof, or foot wall, or in the middle of the height of the seam, it is, on the contrary, a highly favorable circumstance. The *nerf* then takes the name of *houage* or *havage*, and greatly aids the labor of the miner, as we shall have occasion to show hereafter. In general when the *havage* (or interstratification of slate) is at the foot wall of the seam, it is in the most advantageous place.

The reader will obtain an idea of the composition of seams by looking at figures 1 and 2, plate I,* which represents two views, reciprocally perpendicular, of a stratification called in the mines of Le Centre, *les loges*.

It is composed as follows, advancing from the foot wall to the roof:

| | Metre. |
|---|---|
| 1. A layer of coal | 0·18 |
| 2. A second layer separated from the first by a single horizontal fissure | 0·35 |
| 3. Nerf serving for houage | 0·10 |
| 4. Third layer of coal | 0·30 |
| 5. Slaty interstratification | 0·01 |
| 6. Fourth layer of coal | 0·13 |
| 7. False roof | 0.09 |
| | Metre 1·16 |

of which 0·96 is coal.

In Silesia, where the seams have considerable thickness, they are divided into layers by nerfs (*letten schmiere*) of 0.05, 0·10 and even 0·50 metre in thickness. Sometimes they reach a thickness of 1 metre (39 inches), as is the case in the seam called Einsiedel, in the pits *Empress Louise;* the consequence is that it is divided into two distinct seams.

### 19. *Cleavage, or natural divisions of Coal.*

The different layers of coal are separated from each other by joints or lines of contact, the surfaces of which are almost planes

* There are about 75 plates to the work, containing from one to thirty and fifty cuts. Each plate will be given as soon as the text requires a majority of the cuts on it.

always smooth, and sometimes covered with fragments of powder carbon of a vegetable appearance.

These layers are divided between themselves by many kinds of fissures called *cleavages*, a word borrowed from the English, and which has only a remote resemblance to the operation applied to crystalline substances to determine their form.

The cleavages consist sometimes of two kinds of clefts, which so run as to form solid angles, acute, obtuse, and sometimes right, in such a manner that the layers are naturally broken in blocks of a cubic or irregular rhomboidal figure, according to the respective directions of the planes of separation. Sometimes these planes run crosswise in every manner, and the number of them becomes such that the coal is so fractured as to yield only fine coal—a circumstance which is evidently to be ascribed to the convulsive movements formerly experienced by the ground. Bituminous coal seems to be particularly subject to this defect, which is due to its friable nature: it has been more easily and completely dislocated than the other kinds of coal. Thus the seams of this kind of coal, situated in the upper portion of the Belgian formation and so highly irregular, rarely fall in coarse blocks, but more generally in fine coal and fragments of the smallest size.

Sometimes the planes of cleavage are oblique or quite inclined to the plane of stratification; the coal is then obtained in angular masses, on the surface of which we perceive branches of striated lines occasioned by the slipping of the layers while in a plastic state. The coal then comes down in masses, the size of which is controlled by the distance of these meshes from one another, and by the more confined limits of the striated lines.

The cleavage fissures, being a result of shrinkage on the evaporization of moisture, exist in all seams, but they are more or less apparent, according to locality, and, of consequence, render more or less easy the rupture and spontaneous fall of the coal. The cleavages act an important part in the mining of hard coal and thick strata. It is necessary to study well their direction.

### 20. *The variety of Coal in the same Seam.*

The quality of the coal in the different strata of the same seam is rarely identical. It varies the most distinctly from one layer to another, in thick seams where the mass is divided by veins of slate (*nerfs*) of considerable thickness. Thus the *grand mass* of the Rive-de-Gier, where the normal thickness is 10 metres (over 30 feet), is divided into two nearly equal parts by a *barre* called *gore blanc* of 0·20 to 0·60 metre in thickness. The upper portion, called *maréchale*, is highly bituminous, suitable for forges, but it yields very little coal in large masses; whilst the lower portion, called *raffaud* or *raffort*, yields much coarse coal of semi-bituminous quality.

The seam called *main coal* of Staffordshire, although divided by simple leaflets, is not of the same quality throughout its thickness. For five metres in thickness it yields a coal of the first quality for the manufacture of coke and forges, whilst the remainder is of an inferior quality, and is used for steam boilers and puddling furnaces in the metallurgical establishments of the country.

The same fact is equally common in thin seams.

A uniform seam, or one of the layers regarded in respect to a vast extent of the series, presents ordinarily a uniform quality; if it is bituminous, it preserves its bituminous quality for a vast distance; if it is inflammable, it likewise preserves this quality over an immense surface. Nevertheless, it happens that the entire series undergoes remarkable modifications in passing from one point to another, but after having extended a great space. Besides, seams at first highly impregnated with bitumen, gradually lose it and pass insensibly to a less bituminous quality, although they preserve their illuminating quality.

The changes are more manifest and distinct in those parts near the surface of the ground. For (*les affleurements*) the outcrops as they are called, generally show a deteriorated combustible, in consequence of the influence of the atmosphere, of water, and also a mixture of the coal with earthy oxides which deprive it of most of its properties. It then becomes tarnished and friable. It crumbles under the fingers, and it takes the name of *teroulle* or *terre-houille*. This accidental result, which shows itself alike in all localities, should not be confounded with the mineral of the same name furnished by certain seams in the district of Charleroi, Belgium.

### 21. *Structure of the Layers.*

In the same manner as the seams are ordinarily formed of layers, so these latter are generally composed of leaflets, of which the thickness rarely exceeds 0.01 metre, and most frequently does not amount to 0.001 of a metre. They are sometimes slightly undulating and vary according to the structure and quality of the combustible which they contain. M. Burat has found by mechanical analysis or cleavage of the compact coal of the basin of Saone-et-Loire, that they are formed of deposits of a uniform, compact, transparent substance, which is very light, of great purity,* alternately stratified with others less pure, and much mixed with clay, and containing from 20 to 25 per cent. of ashes. They are formed of two species of coal (speculaire and slaty), which are variable in thickness, but those of the brilliant coal are always thicker than those of the tarnished coal. The

* They never contain more than 15 to 20 millims of ashes.

former are frequently met with near the roof, and in the slates adjacent to a seam.

These different stratifications which we can see in the principal part of compact coal, are sometimes accompanied, even in the most bituminous qualities, with some leaflets of anthracite, whose incombustibility in ordinary furnaces renders them easily known.

Sometimes also, we find interventions of *dalöide* coal, a substance which resembles charcoal; it is often in a powdered state, often in that of fragments, and it has a sound like charcoal, and is radiated perpendicularly to its fibres.

22. *Foreign substances scattered through, or stratified in, the mass.*

Coal is seldom pure; its quality is most frequently affected by substances scattered in the mass, and more or less united with it. Thus clay penetrates between the leaflets of coal, and imparts to the latter different degrees of hardness according to the proportion in which it enters into combination.*

Of those substances which are accidental, pyrites, or sulphuret of iron, is the most common. We find it sometimes in lamina between the fissures, sometimes in little layers of a few centimetres in thickness, deposited over a very great extent, as it respects the general stratification, sometimes disseminated in the mass in the state of *geodes*, cubic and octahedral crystals; often, in short, in little grains so fine that they are imperceptible to the naked eye. Pyrites becomes both hurtful and dangerous; when exposed to moisture, it is changed to a sulphate, and produces an expansion which tends to break down the coal in fine pieces, and even reduces it to dust. To this decomposition, combined with a high temperature, we have long ascribed the spontaneous combustion in old excavations, and in deposits of coal on the surface. This substance injures the quality of the coal, and especially renders it unfit for the purposes of many industrial pursuits, in consequence of the disposition of its components to corrode iron, and hence quickly to destroy grates and the bottom of caldrons. Coal rendered impure by pyrites is rejected in the manufacture of iron, as it makes it red short, that is, very brittle. It is easy and not expensive to separate from the coal the sulphurets of iron in a state of leaflets; but if they are found in scattered fragments, there is no means by which to separate them.

The carbonate of lime containing iron or magnesia, is likewise found mixed with coal in the same manner as clay, but this is

* The purity of coal, as compared with the earthy matters which it contains, is estimated by the weight of the ashes. Coals are is regarded as having a high degree of purity, when they contain only 2 or 3 per cent. of ashes, but when that proportion rises to 9 or 10, they lose their quality, assume a flat consistence and become hard.

rare; it is more frequently met with as crystals, or in lamina or thin leaflets, stratified between two layers or deposits. In short, galena, blende, and the oxide of titanium under the form of little red crystals, are likewise met with.

### 23. *Thickness and workable nature of Seams.*

Coal seams are very irregular in their thickness. Sometimes they consist only of a simple indication of carbon; at others, on the contrary, they are 5, 10, 20, and even 60 metres, and all the figures comprised between a few millimetres, and these extreme ones express their thickness.

It is impossible to decide *a priori* whether a seam is workable or not; this conclusion is derived not only from its thickness, but likewise from the expense necessary to incur in order to mine it, as compared with the price for which it will sell. Thus one stratification, which would be neglected in one locality under the latter consideration, might be worked with profit in another, where labor is cheaper, or where the supply of coal is comparatively less for the demand. It is thus in the environs of the Hartz, where coal is scarce and indispensable for metallurgical purposes; there seams of 15 to 20 centimetres are worked with profit, which would be considered ruinous in other countries more favored by nature. The good quality of the coal can likewise render a seam workable, which, without that, would not be considered as such.

The little coal stratifications, even those where the coal is only some centimetres in thickness, are very useful to the miner, when searching for a seam lost; or, if it is thrown down, in determining the situation of its foot-wall and roof.

When considered in respect to their workable character, all seams may be divided into three classes:—

1st, *Thin* seams, beginning at a point where they are workable, and increasing to 1.50 metre and 2 metres* in thickness. Within these limits are comprised those of the Belgian basins, of the Department of the North, of Sunderland, of Durham, and the larger part of those contained in the deposit of the Ruhr.

2nd. *Thick* seams, embracing the series comprised within 1.5 metre, and 5 or 6 metres, among which we find a large part of those of the basins of St. Etienne, of Rive-de-Gier, and some of Upper and Lower Silesia.

3rd. *Very thick* seams, the thickness of which exceeds 5 or 6 metres; examples of which are the great seam of Creuzot, the average of which is 12 metres; that of Epinac of 10 metres; the grand mass of the Rive-de-Gier; certain stratifications of the

* A metre is about 39 inches.

basin of St. Etienne; that of Montchanin which attains in some places 70 metres; that of Staffordshire, called *main coal* or *ten yard seam*, &c.

24. *Seams considered, relative to their Thickness, Number, and Extent.*

Coal seams are rarely isolated. We usually find more than one in the same deposit. It seems that their number is in inverse ratio with their thickness, and sometimes in direct ratio with their extent (*continuité*). Thus the basin of Liege contains, according to M. Dumont, 83 workable seams, and it is probable that that of Mons contains at least 116. Their thickness is comprised between 0.20 metre and 0.70 metre; sometimes they reach a metre in thickness, but those of two metres form a very rare exception. In these localities the continuity of the seams is extensive. The same is true of the basin of Newcastle, where we count 40 seams varying from some centimetres to 2 metres.

In those basins where there is the smallest number of seams, the thickness is, on the contrary, very great; thus in the Departments of the Centre and South of France, a thickness of 1.50 metre to 2 metres is very common; seams of 5 to 6 metres are not found in all the deposits. Those of 10 to 50 metres, more rare still, are often isolated, or only accompanied by some very thin ones. Creuzot, for example, has only two or three besides the one which is worked. The concession of Epinac, only one. The *ten yard* seam of Staffordsire has only 6 or 7. That of Johnston, near Paisley in Scotland, is the only one; etc., etc.

It often happens, that the very thick seams are not subject to a law of extent like the thin or the average ones; that of Creuzot seems to extend only 1800 metres, and that of Montchanin, the thickest known, is very limited in respect of its direction, since its length does not exceed 600 metres.

In general the *lacustrine* formations, the seams of which are usually thick and few in number, rarely present a well established character for continuity. They rather contain isolated and circumscribed deposits, without any other analogy than a tendency to follow a uniform direction. The enclosing rocks are chiefly formed of the debris of the subjacent series. The *marine* deposits, on the contrary, such as the great coal zone of Belgium, likewise the English basins, and most of those in Germany, are remarkable for the number of their seams, which are generally thin. So far as relates to the enclosing series, they are rocks foreign to the formation which supports them, and consist of grains finer and more triturated by being brought from long distances, than the rocks of the *lacustrine* basins.

25. *Relation existing between the geological position of the Seams, and the quality of the Coal which they contain.*

In some localities the seams appear to form among themselves distinct groups, arising from the character of the coal which they yield. Thus the strata in the mines of the deposit at Mons are divided into four systems or groups, in which the coal becomes more uninflammable as it is found near the oldest formation. The change from one group to the other is not made in a sudden and distinct manner; on the contrary, the characteristics are little by little changed, and so gradually indeed, that it is extremely difficult to discern the line of demarcation, which separates the consecutive groups. The same fact occurs in the districts of the Centre and of Charleroi, where the seams become more and more bituminous as they approach the surface. Those of the basin of Liege, which as M. Dumont thought, could be divided into three ranks; the lower system containing only uninflammable coal, the middle composed of semi-bituminous, and the upper, which is very bituminous, also confirm this very general fact. The ten seams of South Wales, which occupy the lower part of the basin, belong exclusively to the dry (uninflammable) coals. The uninflammable coal worked at Fresnes, and at Vieux Condé, are geologically situated beneath the bituminous coals of Anzim, of Denain, etc. Not to multiply examples, we may conclude that in general, the uninflammable or dry coals belong to an age more remote than the bituminous coal, and that the intermediate seams form the transition which unites these two extremes.

The metamorphic theory, that is, the theory of the change that sedimentary deposits undergo when they are subject to the influence of the rocks of igneous origin, affords a very satisfactory explanation of these remarkable facts.

In short, the internal heat of the earth which, during the coal period, was dissipated from the earth in greater intensity than subsequently, traversed the transition series upon which reposed the carboniferous formations, and by its action on the coal, gradually changed its chemical nature. The lower seams being more exposed to the metamorphic action than the others, are more highly mineralized, as they were nearer the centre of heat, and were subjected to more energetic pressure.

The upper strata, being less exposed to the influence of fire, have undergone little or no modification, and retain a considerable quantity of gas. It is to the effects following from different degrees of the igneous influence, that we must ascribe the variations in the quality and composition of coal from the same basin. To the same cause also, is to be assigned the different qualities of the same seam when worked in different localities.

## 26. *The distinctive Characteristics, and the Identity of Coal-Seams.*

The characteristics by which coal-seams may be distinguished from each other, are the following:—

The number of layers (*assises*) composing them; their thickness and texture; the quality of the coal and its hardness; the nature of its cleavage; the presence or absence of slaty layers, their position, number, thickness, and the nature of the substances of which they are formed. The constitution of the roof and foot-walls; their solidity, or fracture; their bituminous quality; the vegetable or animal impressions in the containing rocks, and the place they occupy; the small seams or *veinettes*, interspersed between the roof and foot-wall; in short, the distance of the seam which is the object of exploration from others already known.

Some of these characteristics are often not present, but this is never the case with all of them. The miner should apply himself to learn every particular; it is thus only that he can establish the uniformity, or, in other words, determine that different portions of stratification are merely an extension, and constitute only a single seam. This knowledge is indispensable, in order to assign their true name to those encountered in driving a transverse gallery in localities but little explored, and consequently to enable the miner to determine at each moment his position. It is the only observation effectual for pointing out the bearing of a lost stratum, and for preventing dangerous mistakes in an exploration.

To succeed in tracing an extension of this kind, when the points of observation are at such distance from each other, that the characteristics have changed, the thickness increased or diminished, the continuity destroyed by frequent faults, and when, in short, confusion is established in the strata, is sometimes an extremely difficult, not to say impossible, task. In this case the miner refers to the enclosing rocks, among which he may be able to meet a well-marked bed of sandstone, or slates, having impressions in them, or any other strata which preserves an unchanged course throughout the surface under exploration. It is a *plan of bench marks* (plan de repéne) which serves him from the point of departure, for the classification of the seams lying above and below. Sometimes one or two geological *observations* together, are sufficient to establish the complete uniformity of the strata of an entire formation. In the basins of Belgium, the beds of coal sandstone, usually very rare, their alternates, and the unworkable small veins (*veinettes*) observed in opening shafts and galleries, or on the examination of the outcrop, are the elements to which we must resort, to determine the continuity of seams.

It is by means of the identity that we can determine the actual surface each occupies; this element added to the average thickness, enables us easily to deduce the cube or solid contents.

Then excluding the unprofitable portions proved by incomplete developments, and the spaces occupied by disturbances and faults of the series, we obtain an approximate estimate of the mineral riches contained in any portion, or even in the entire basin. The solid contents of seams is therefore only the investigation of their identity, their thickness in pure coal, and, in short, their boundaries, having regard to the loss arising in the mining, to the increase in bulk, etc.

### 27. *Tendency of certain Seams to push into vacant spaces.*

It appears that seams, under the influence of certain circumstances, have a tendency to occupy a greater space than has been assigned to them by nature. Suppose one of them to be partly excavated and subsequently abandoned; if, among the props of the roof, there has been an occasion to place one directly against the coal uncovered, we shall upon visiting the spot after an indefinite lapse of time, find that it appears to have become completely enveloped in coal. This very energetic result of which we are often witnesses, in working certain strata, can be ascribed to the pressure of the roof on the seam, and especially to carbonated hydrogen gas, which, striving to escape, fractures it, causes it to increase in bulk, and produces an upheaval, from which one would be led to infer an increase in the volume of the coal.

This circumstance has given occasion to an opinion, which was formerly extensively entertained in the province of Leige; to wit—that the enclosing rocks contained the generating elements of coal; that they unceasingly re-produced this combustible, thus refilling anew the spaces opened in working the coal, and constantly restored things to their primitive state.

It is owing to the above causes that the miner upon resuming his work in a gallery which has been abandoned for some time, obtains for some metres in his progress only fine and broken coal, even, indeed, until he reaches the point where the pressure from the roof and the disengagement of gas have ceased to exert an influence.

### 28. *The origin of Coal, and of the vegetables which have contributed to its formation.*

Nearly all geologists unite in the opinion, that coal is produced by the decomposition of marine or terrestrial vegetation, distributed upon surfaces of variable extent. This, placed upon more ancient deposits of sand, and clay, and covered in turn by other deposits of a similar nature, has constituted the first seam of coal with the enclosing rocks. Similar operations succeeding at irregular intervals during an indefinite period, the compression to which the beds of clay and sand become subjected, increasing

in energy with the progress of the accumulation, transform them into slates, sandstones, and seams of coal, which being originally of greater thickness, thus acquire compactness and are reduced to their present breadth. *

Because the distillation of coal always yields a certain quantity of ammonia, some naturalists have believed that certain animal substances entered into its composition. The remains of fish, mollusca, and shells contained in the enveloping rocks, and then in the coal itself, strengthen this opinion.

We are ignorant of the manner in which decomposition has transformed into a combustible such enormous masses of vegetation; indeed, there exists upon this subject very many hypotheses which cannot properly find a place within the compass of this work.

So far as relates to the origin of the woody materials, the geologists have, on this subject, put forth two distinct opinions.

According to one class, the vegetation of that remote period being under the influence of a hot temperature, and favored, also, in its growth by a humid atmosphere, and being highly charged with carbon, has increased with great vigor at points adjacent to the coal basins; subsequently being broken down, and suddenly destroyed in part or entirely, it would form a vast raft, which, driven by currents, would be lodged in places where we find the carboniferous formation. Meantime the elements of the enclosing rocks will be deposited as sediment; a new growth of vegetation would furnish a new raft; thus innumerable similar operations, occurring at different periods, would suffice to create the carboniferous basins, and the coal would be the result of a sedimentary deposit.

M. Elie de Beaumont, with the design of combating this hypothesis, proves, by an estimate of the quantity of carbon contained in a given volume of vegetable matter, that seams of 1, 2, and 30 metres in thickness, would require in their formation floating rafts of 26, 52, and 780 metres in height, and he concludes that such a thing is impossible. But the seams being formed by layers which are themselves subdivided into very thin leaflets, it is not necessary to conclude that even the thinnest has been formed from a single transport of vegetation; on the contrary, it is more probable to suppose, that it has received the increase of many successive rafts which have become superin-

* M. Beaumont, by an estimate of the quantities of carbon which vegetables yield, proves that under the most favorable circumstances, the forest vegetation of a century would yield, after decomposition and transformation, only about 0.016 of a metre of coal in thickness; and a seam of 10 metres in thickness (3 feet) would require sixty-two centuries for its formation. What lapse of time is thus required for the formation of the most powerful seams, and even for an entire deposit! But this theory is not inadmissible, since nature, in her works exhausts almost an infinity of time.

cumbent, either with or without the intervention of a slaty leaflet. The impossibility in this case does not consist mostly in the height of the floating mass; but it is with difficulty we can comprehend the steady coincidence of innumerable deposits upon the same surface, in order to form seams which are not only perfectly stratified, the thickness of which does not vary, sometimes, 0·10 of a metre for many kilometres in extent; and where the series is so numerous as is found in most coal deposits.

Again, the transportation of wood, like that which takes place, at the present clay, at the mouth of great rivers in America, proves, that its removal cannot occur without being accompanied with a mass of earthy substances, so great, that a stream of water could not heap up the woody matter of a seam without its being intermingled with a greater amount of slime than carbon—this circumstance is inconsistent with the constitution of coal, which in its state of greatest impurity never contains more than 10 to 20 per cent of foreign matter.

In consequence of these impossibilities, Messrs. Adolphe Brogniart, Elie de Beaumont, and Amadie Burat, reviving the hypothesis formerly entertained by Deluc of Geneva, MacCullock, and many other writers, think to have assimilated the coal to the peat deposits, in admitting that their origin is due to a growth of vegetation in place.

According to this system, two species of vegetation would have existed in the marshy plains of that primitive epoch; one consisting of branching ferns, gigantic calamites, and some grand species, the fossils of which we actually find reclining or upright in the slates and sandstones of the deposit; the other consisting of aquatic and herbaceous plants, increasing in the same manner as peat. The vegetation of the first species must have almost entirely furnished the elements of coal flora, since that of the second, to which we have assigned the origin of seams, would leave only feeble traces, and these generally very indistinct. The waters penetrating the spongy mass, determine its stratified condition, disorganize the tissues and separate the different layers of combustible, already more or less penetrated by earthy matters. The motion of the waters shown by the torrents of rain peculiar to a hot and moist climate, would cause to be held in suspension or solution various substances; these, by virtue of their chemical affinities, would be reciprocally attracted, and produce kidneys of carbonate of iron, slates, sandstones, and other accidental substances frequently found in strata. In short, one supposes a wave of water extending over a tenacious ground, forming at every occasion a seam of coal, or a bed of clay abounding in impressions, and which usually becomes the roof, or foot wall. This wave or flow has been able to continue at the surface of the basin during all the period of the deposit of the superincumbent slates. But here a serious difficulty offers, if one desires to reconcile the

vegetation in place, with the numerous alterations of combustibles and the enclosing rocks, and especially the great thickness of the entire deposit. How, in short, has it been possible for the flow of water so indispensable to the formation of the deposit to continue through all the stages to which the strata has been successively elevated? How has it been able to maintain in the limits its volume? The authors of the hypothesis say:—that at that remote period, the crust of the globe, still thin and slightly solidified, has yielded under the weight of the deposit in proportion to its formation, and thus the waters have not changed their level;—that this gradual sinking of basins explains the alterations of coal and the barren rocks; and it will perhaps afford reasons wherefore the secondary period presents only rare specimens of seams, deposited in strata little developed. But this circumstance, ascribed to the solidification of the crust of the globe, will then be opposed to the successive sinking of the other.

Such is the hypothesis upon which to enable us to conceive of the possibility of all the phenomena of this primitive period in a full and satisfactory manner.

(To be continued.)

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ART. V.—THE IRON MANUFACTURE OF GREAT BRITAIN—THEORETICALLY AND PRACTICALLY CONSIDERED.—By WM. TRURAN, C. E. No. 4.

[Continued from page 15.—Vol. VI.]

## THE BLOWING-IN OF BLAST FURNACES.

THE blowing-in of a blast furnace is an operation demanding great care and an intimate acquaintance with the management of furnaces. If hastily done, the injury to the furnace may be such as to require its being blown out, to be repaired; and if due attention is not paid to the mixture of materials for commencing with, the results will be unsatisfactory; much difficulty experienced; and time lost in bringing the furnace into a healthy working condition.

The arrangements for blowing-in having been completed, in the manner described in the preceding section, a quantity of rough dry timber is placed in the hearth, filling it to a height of 5 or 6 feet; on this wood a quantity of coke is deposited from the top, filling the remainder of the hearth and also the boshes. Fire is applied to the timber, which quickly communicates to the cokes above. Regular charges of calcined ore, limestone, and cokes, are now filled in until the materials reach the throat of the furnace. The proportion of ore and limestone to coke varies in different localities, but at the works around Merthyr Tydvil, the

first charges generally consist of 5 cwts. of calcined argillaceous ore, and 1¾ cwt. of limestone to 4 cwts. of coke containing a large per-centage of carbon. Where the rich hematites are to be smelted, the filling above the cokes will be conducted in a different manner. These ores cannot be successfully introduced in quantity before the furnace is brought into working. If leaner ores are not obtainable, the mixture of materials at commencement may be good gray cinders, with a small burden of calcined ore and limestone. On these materials it will be well to let the furnace run for some days, or until a regular floor of good cinder is obtained at the fall, when the burden of ore may be increased, and that of cinders diminished.

Every thing having been arranged for its admission, blast is let into the tuyeres and the furnace "blown-in." At first, the tuyere pipes are of small diameter, but in this, as in too many other matters connected with the manufacture, no fixed rule exists, and a great difference in the size of the nozzles employed in blowing-in furnaces, at the same works, may be observed in practice. And yet with similar ores and fuels, smelted in furnaces of the same internal dimensions, the diameter of the first set of pipes should bear some proportion to those eventually adopted for a full blast. We have endeavored to arrive at some fixed ratio, and from the dimensions of those employed in blowing-in eleven furnaces under our immediate observation, we find that the average area of the pipes through which blast is first delivered, is one-fifth of the area of the pipes ultimately employed. With this proportion, all risk of failure in the operation, and of subsequent injury to the furnace, will be avoided.

For a furnace of an internal capacity of 275 cubic yards, and intended to be blown with 4 inch nozzle pipes, the first set will be 1¾ inch bore. After blowing about 30 hours, these may be replaced by a set of 2¼ bore, increased at the expiration of three days to 2¾ inches. In ten days from the time of blowing-in, the bore may be altered to 3¼, and in three weeks to 3⅝. Full size pipes may be used in four or five weeks after blowing-in.

Cokes are invariably used as the fuel in blowing-in coal and coke furnaces, but if raw coal is to be used in the subsequent operations, the substitution may be made in the first charges after blowing.

The burden of ore and limestone described, should be kept on unaltered for ten days, in which time the furnace will go from 400 to 450 charges. It may then be increased to 6 cwts. of calcined ore, and 2⅛ cwts. of limestone to a similar weight of carbon; with this burden it will go about 400 charges the first week after alteration, increasing however to 650 or 700 in the third or fourth week. If the furnace is intended for forge iron, the alteration in the burden should not be made until it has worked successfully for three or four weeks on gray iron.

After the application of the blast, the attendant founders will commence clearing the hearth below the tuyeres for the reception of cinders. These will make their appearance in about 12 hours after blowing. In 24 hours they will have filled the hearth to a level with the notch in the dam-plate, and in three days will flow in quantities sufficient for their direction, through the troughs to the cinder tubs.

The metal will appear in about 10 hours after the cinders, and collect in the hearth to the amount of 3 or 3½ tons in 60 hours after blowing. In about 18 hours afterwards, another casting of about two tons may be made: from this time the operation of casting may be performed at the usual stated periods, once in 12 hours or oftener. The quantity of metal at each casting will increase from two tons the second cast, to about five tons in the fourth week. From the first week's blowing the produce of metal will be about 22 tons; from the second 38 tons; from the third 55 tons; while the fourth week's make will not fall short of 80 tons. With the burden stated, and a full blast, the produce will average 110 tons at the expiration of 10 or 12 weeks, but a greater weekly make than this cannot, under existing circumstances, be permanently obtained from that size furnace, working on lean argillaceous ores for foundry purposes.

Forcing the furnace, that a greater produce of iron may be obtained, is attended with the most injurious effects on its subsequent working. In the present day, the majority of furnaces put in blast are permanently injured by this forcing. The desire of making immediate returns outweighs all considerations regarding the certain destruction of the boshes and hearth. The blowing is accomplished with large pipes, and the furnace filled and worked with rich ores, or calcined ore, and forge and finery cinders. White forge iron and a dark scouring cinder are the inevitable results of this proceeding. The produce is considerable for a few weeks, then it diminishes, and a great difficulty is experienced in maintaining the furnace in working order. Alterations are now made in the burden, the volume of blast is diminished, and the forcing system compulsorily suspended for a period, in order to remedy the evils which a more temperate proceeding would have avoided. If the altered mode of working is persevered in for some weeks the condition of the furnace is generally much improved, and, although irreparably injured, may continue in work for a considerable period. But more commonly the system is carried on till the boshes are entirely destroyed, the hearth nearly so, and the brickwork around the tuyeres and over the fall thinned, to that extent, that their outsides are maintained at a red heat. The breast is generally one mass of red hot bricks; and through this and the tuyere stoppings the pent-up flame will frequently burst, showing that the interior work has been destroyed. The bricks indeed are clearly distinguishable in the cinders, and it is from the

quantities raked out that we are enabled to determine the rate of destruction. The bottom of the hearth is repaired with fire-clay from the front, but there is no access to other portions of the hearth, or the boshes, while the furnace is in blast. This circumstance should be well considered, when it is proposed to force a new furnace to a large weekly make. Eventually the make of the furnace is greatly diminished, the crude iron produced is of the worst quality; the yield of fuel to the ton of crude iron increases in an inverse ratio to the quantity made, the yield of ore is also increased, and a dense black cinder flows sluggishly from the hearth. In a few weeks the increase of cost consequent on the increased yield of materials, and diminution of make, becomes so great, that blowing-out and refitting the interior work is adopted as the only available remedy.

A notable instance of this forcing system occurred in the last year at the Abersychan works. A furnace was blown-in with such volumes of blast and rich burden of materials, that a cast of several tons was obtained within 14 hours after applying blast. And the first week's blowing produced 200 tons, at which rate it continued for two or three weeks when it rapidly diminished, falling so low as 19 tons for one week's make. From this deplorable state it was made to produce 26 tons, and after considerable delay, 100 tons; but with a large increase in the yield of materials over that at the other furnaces.

The admission of blast of a high density in large volumes at the blowing-in, must exercise a very prejudicial effect on the duration of the brickwork of the interior. If the volume is large—similar to that at the Abersychan furnace, where the melting temperature of pig iron was created, and pervaded the hearth in a few minutes at a corresponding temperature, the materials within the boshes, the destruction of the hearth and boshes is inevitable. Brickwork cannot withstand a sudden accession of temperature like this. Stone work also will not continue sound. If the bricks are well manufactured, and carefully set, the high temperature of the ascending gases will loosen them from their beds, and the descending materials striking on the projecting part, they are displaced and descend with the current of materials to the hearth. This displacement of the work is accelerated if the materials smelted are of a rich quality, and there is a deficiency of flux. It is well known that the cinders ordinarily produced in a furnace will, on flowing over brickwork, give it a glaze which materially protects the work from the action of the metal. This glazing is successfully accomplished, where a small blast and suitable burden of materials are used; but with a large blast and rich burden, the cinders are of a hot scouring nature, containing a large per-centage of iron, and as the temperature of the work is kept too high for the operation it does not secure the protection of a cinder glaze, and is readily acted on by the crude

iron. The corrosive action of the fluid metal on the unprotected brickwork is forcibly shown in the rapid manner in which portions of the hearth in well regulated furnaces are destroyed. The face of work inside, at and below the level at which the metal stands before tapping, has to be renewed every six or eight days with fire-clay tightly rammed into the hollows. This repairing clay has not, from the few hours which elapse before it is covered with metal, had the necessary time to obtain a glaze from the cinder, and therefore is rapidly destroyed by the metal to be renewed under similar circumstances.

## THEORY OF THE BLAST FURNACE.

The blast furnace employed for the reduction of iron ores into metallic iron, may be considered as an immense laboratory, wherein the most varied chemical processes are conducted with a regularity and rapidity equalled only by the magnitude of the operations performed. In the largest furnaces the weekly consumption of atmospheric air amounts to 2,318 tons by weight, and of solid materials, ore, fuel, and flux, 883 tons—total 3,201 tons, or more than 20 tons per hour. By the chemical processes of decomposition and recomposition in operation within the furnace, this weight of gaseous and solid materials is resolved into 485 tons of liquid and 2,716 tons of gaseous matter. The solids are introduced into the furnace at the tunnel head, the gases—atmospheric air—through the tuyeres at the hearth. The liquid products of the furnace are obtained from the hearth in the form of cinder, slag, or scoria, from a high level, and crude iron from the lowest level. The gaseous products escape at the tunnel head, and comprise nitrogen, oxygen combined in determinate proportions with carbon forming carbonic acid; and carbonic oxide, hydrogen, hydrogen in combination with carbon, as light carburetted hydrogen, and other gases in lesser quantities.

Hence it will be seen that in the smelting furnace, we have a descending column of solid materials which enters at the throat, and is resolved into gaseous and liquid products, the latter escaping at the bottom, and the former at the throat, and an ascending gaseous column which enters at the bottom and escapes at the throat of the furnace.

The changes which the ore, fuel, and flux undergo during the smelting process will be best examined if we consider, first, the changes produced in the descending column of solid materials; secondly, the changes produced in the ascending body of atmospheric air; and thirdly, the chemical action produced by the contact of the descending and ascending columns.

The changes which occur in the descending ore, commence with the uncalcined ores in the throat of the furnace. They lose their moisture and volatile gases before they reach the level of

the boshes, absorbing from the fuel the necessary caloric for calcination. Below this, the ore is gradually converted from a peroxide into a magnetic oxide, or as sometimes occurs, into metallic iron; having combined with a portion of the carbon from the fuel to form the fusible carburet of iron. From the bottom of the boshes to the level of the tuyeres, the reduction of and flux into a liquid mass is completed. The fusion of and flux occurs at a height of 8 or 10 inches above th from whence it descends into the hearth. Here the m its greater specific gravity falls to the bottom, freed m from the fluid cinder which floats on the surface, and from the oxidizing influence of the blast.

In the fuel little change is supposed to take plac used, until it arrives within the boshes; but if an un used, a rapid transformation takes place, commenc ately on its entering the throat. Hydrogen and ligh hydrogen gas are expelled, a portion of the carbon and during its descent to the boshes the coal has p volatile gases, and is converted into a porous coke. descent a portion of the carbon is absorbed by the the top of the hearth to the tuyere the fuel is c sumed—the greatest consumption occurring a fe the centre of the tuyere.

The flux undergoes a change from the time among the ignited materials. Raw limestone the caloric absorbed from the fuel causes the ex bonic acid, thereby converting the stone into In its further descent the flux undergoes little reaches a level immediately above the tuyere, in combination with the earthy matrix of the the hearth.

The ascending column of air entering the furnace through the tuyere is decomposed immediately on coming in contact with the ignited fuel. Its oxygen combines with the vapor of carbon forming carbonic acid, and the liberated aqueous matter furnishes hydrogen and oxygen, which latter combining with carbon produces carbonic acid, and carbonic oxide. Ascending to a few inches above the line of fusion, the carbonic acid is converted into carbonic oxide, by oxidizing a second equivalent of carbon. At this level the column consists of nitrogen, carbonic oxide, and hydrogen. Above the zone of fusion, in the region of the boshes, carbonic acid again appears, the hydrogen increases, light carburetted hydrogen forms a portion of the column, and the volume of carbonic oxide and nitrogen diminishes. Ascending to the level of the boshes, the carbonic acid, hydrogen and light carburetted hydrogen decreases, while the proportion of carbonic oxide and nitrogen is augmented. Half way up the body of the furnace, the volume of light carburetted hydrogen and hydrogen

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The qualities and composition of the ore, fuel and flux, and the ratio which they bear to each other in the descending column, will modify the composition of the ascending column; while the form of the furnace, volume of blast, and mode of application, have an important influence on the volume of gaseous carbon at the level of escape.

If the ore has much water in mixture, its decomposition liberates hydrogen and oxygen. These gases by combination with the carbon of the fuel form hydro-carbons, carbonic acid, and carbonic oxide, in unknown quantities. With the softer varieties of coal, containing a large per-centage of volatile gases, the volume of hydrogen and hydro-carbons will be augmented, and consequent on the larger quantity of gaseous carbon evolved in the upper regions, the carbonic oxide is increased, and the carbonic acid and nitrogen diminished in the throat. The calcination of the limestone in independent furnaces results in a large diminution of the volume of carbonic acid.

By contracting the throat of the furnace, a high local temperature is maintained, and a partial combustion of the fuel effected. In consequence of the abundance of vapor of carbon, the ascending carbonic acid absorbs a further equivalent of carbon, and is converted into carbonic oxide; while the volume of carbon, combined with hydrogen is augmented, according to the combustibility of the coal, and its yield of hydrogen.

Although generally adopted as an ascertained fact, the entire conversion of the recently formed carbonic acid into carbonic oxide immediately above the entrance of the air requires to be confirmed by more accurate researches. By the means employed by chemists for withdrawing the gas, viz., by piercing the sides of the furnace, or sinking narrow wrought iron tubes along with the materials, it is impossible to accurately determine the composition of the ascending column. In ascertaining the composition of the gases over the zone of fusion, the former method has invariably been adopted, and carbonic acid is discovered wanting. Now it is highly probable that an ample supply of oxygen to a portion of the fuel, may result in the formation of a centre column of carbonic acid, but from a deficiency of oxygen to the fuel next the walls, this column is surrounded with carbonic oxide. The relative quantities of carbonic acid and carbonic oxide, will depend on the efficiency of the means adopted for the union

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In the fuel little change is supposed to take place if coke is used, until it arrives within the boshes; but if an uncoked coal is used, a rapid transformation takes place, commencing immediately on its entering the throat. Hydrogen and light carburetted hydrogen gas are expelled, a portion of the carbon is consumed, and during its descent to the boshes the coal has parted with its volatile gases, and is converted into a porous coke. In its further descent a portion of the carbon is absorbed by the ore, and from the top of the hearth to the tuyere the fuel is completely consumed—the greatest consumption occurring a few inches above the centre of the tuyere.

The flux undergoes a change from the time of its reception among the ignited materials. Raw limestone being employed, the caloric absorbed from the fuel causes the expulsion of the carbonic acid, thereby converting the stone into an oxide of lime. In its further descent the flux undergoes little alteration, until it reaches a level immediately above the tuyere, where it is fused, in combination with the earthy matrix of the ore, and falls into the hearth.

The ascending column of air entering the furnace through the tuyere is decomposed immediately on coming in contact with the ignited fuel. Its oxygen combines with the vapor of carbon forming carbonic acid, and the liberated aqueous matter furnishes hydrogen and oxygen, which latter combining with carbon produces carbonic acid, and carbonic oxide. Ascending to a few inches above the line of fusion, the carbonic acid is converted into carbonic oxide, by oxidizing a second equivalent of carbon. At this level the column consists of nitrogen, carbonic oxide, and hydrogen. Above the zone of fusion, in the region of the boshes, carbonic acid again appears, the hydrogen increases, light carburetted hydrogen forms a portion of the column, and the volume of carbonic oxide and nitrogen diminishes. Ascending to the level of the boshes, the carbonic acid, hydrogen and light carburetted hydrogen decreases, while the proportion of carbonic oxide and nitrogen is augmented. Half way up the body of the furnace, the volume of light carburetted hydrogen and hydrogen

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top, that the quantity of gaseous carbon in the gases is deter-
mined. Under circumstances which exist at numerous furnaces
in this country, the entire volume of carbon escapes as carbonic
oxide, and in combination with the hydrogen: while under dif-
ferent conditions the carbonic oxide is nearly absent, the hydro-
carbons reduced to a minimum, but carbonic acid is present in
large quantities. In the latter case, the carbon charged into the
furnace has yielded a maximum effect, but in the former the
excess of carbon in the escaping column, as shown by the large
volume of carbonic oxide and hydro-carbon, is evidence of a
minimum effect being produced by the combustion of the fuel.

The effects produced in the descending materials by the as-
cending columns of gas are not well ascertained. From the data
at our disposal, and our own observations, we consider, that but
little chemical action ordinarily takes place in the upper part of
the body, if the form of furnace is favorable to the coal retain-
ing its carbon. The ore, fuel, and flux part with their volatile
constituents, principally hydrogen and aqueous matter, which is
in greatest abundance the nearer the ascending column is to the
throat. The expulsion of the carbonic acid of the limestone, and

* In the numerous analyses of blast furnace gases the absence of all information respecting the gases in the region of the boshes is very remarkable. The difficulty of piercing the greater thickness of work in this locality appears to have deterred the experimenters from collecting the gases from within the boshes—hence the gap in the analysis. To this circumstance we ascribe many of the inconsistencies observed in the analysis, and for which no explanation is given, though they vitiate the conclusions drawn by the experimenters of the chemical action of the blast furnace.

It is maintained by chemists that the oxygen of the air and carbon of the fuel form carbonic acid; but by the oxidizement of a second volume of carbon vapor, this gas is immediately converted into carbonic oxide. Higher up, a portion of the carbonic oxide is converted into carbonic acid, by combining with the oxygen of the ore. The level wherein the carbonic acid appears again cannot be accurately defined, but in furnaces working on similar ores and fuels, we may safely infer that the range is not great. According to M. Bunsen's analysis of the Vickerhagen furnace gases, at 5½ feet above the tuyere, the ascending column contained nearly 9.3 per cent. by weight of carbonic acid. Now in M. Ebelman's analysis of the Clerval furnace gases, at 8 feet above the tuyere, the column does not contain any carbonic acid gas. If M. Bunsen's analyses are correct the Clerval gases should contain nearly 12 per cent. of carbonic acid at this elevation above the tuyere.

With the two most eminent authorities on the composition of furnace gases differing so very widely in their analysis, are not we justified in stating that little reliance can be placed on their researches in this department of metallurgy?

the aqueous vapor of the ore, renders latent a portion of the heat evolved by the coking of the coal. Lower down, the carbonic oxide of the ascending column reacts on the oxygen of the ore, producing carbonic acid, and converting the ore into a magnetic oxide. This reaction appears to be continued further down, but from the rapid descent of the materials, the deoxidation and carbonization is principally performed in the centre and lower regions of the body. Down to the top of the hearth the fuel should contain nearly its original quantity of carbon; below this level the consumption is effected with astonishing rapidity. The chemical action going forward in the hearth, consequent on the admission of the blast, results in the ore losing its remaining oxygen; carbonic acid and carbonic oxide are formed, the ore completely deoxidized combines with a small portion of carbon, and arriving with the flux at the intense heat generated by the blast on the fuel above the level of the tuyere, a fusible compound of carburet of iron silica, lime, and alumina is formed, which drops below the tuyeres into the hearth beyond the oxidizing influence of the blast. This compound eventually resolves itself into two distinct layers of liquid matter. In the lowest and thinnest stratum metallic iron preponderates; carbon, silica, alumina, manganese, magnesia, phosphoric acid, sulphur and lime will be present in small quantities, the whole forming the crude iron of commerce. The upper stratum consists of silica, lime, alumina and crude iron, this last in considerable quantities when the furnace is improperly burdened, or its working from any cause is deranged.

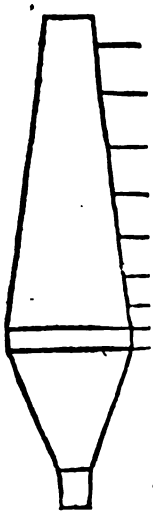
### COMPOSITION OF THE GASEOUS PRODUCTS OF THE FURNACE.

Experiments were made a few years since at the Alfreton Furnace, Derbyshire, with a view of ascertaining the composition of the gases at various depths from the top.

We annex Messrs. Bunsen and Playfair's analyses of the gases from this furnace. For facility of reference, a section of the furnace is placed alongside, and the analysis placed at depths corresponding to the depth of the tube.

A narrow iron tube was sunk along with the materials, and the escaping gas when immersed at various depths, collected and analyzed. The results, though probably the most correct of any experiments hitherto performed, must be received with a due allowance for error, and for the theoretical views of the analyst.

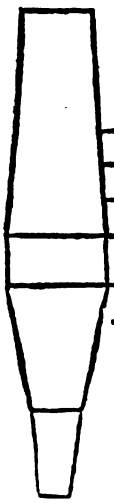
*Analysis of the Alfreton Furnace Gases.*



| Depth from the top in feet. | Nitrogen. | Carbonic Acid. | Carbonic Oxide. | Light Carbut. Hydrogen. | Hydrogen. | Olefiant Gas. |
|---|---|---|---|---|---|---|
| 5 | 55.35 | 7.77 | 25.97 | 8.75 | 6.73 | 0.43 |
| 8 | 54.77 | 9.42 | 20.24 | 8.23 | 6.49 | 0.85 |
| 11 | 52.57 | 9.41 | 23.16 | 4.57 | 9.33 | 0.95 |
| 14 | 50.95 | 9.10 | 19.32 | 6.64 | 12.42 | 1.57 |
| 17 | 55.49 | 12.43 | 18.77 | 4.31 | 7.62 | 1.38 |
| 20 | 60.46 | 10.83 | 19.43 | 4.40 | 4.83 | 0.00 |
| 23 | 58.28 | 8.19 | 29.97 | 1.64 | 4.92 | 0.00 |
| 24 | 56.75 | 10.08 | 25.19 | 2.33 | 5.65 | 0.00 |

| 34 | 58.05 | 0.00 | 37.43 | 0.00 | 3.18 | Cyanogen. 1.34 |
|---|---|---|---|---|---|---|

The analyses made by Messrs. Sheerer and Langberg, of the gases from a foreign charcoal furnace, gave results very different from the foregoing, as will be seen by the following diagram and table of analysis.



*Analysis of the Baerum Furnace Gases.*

| Height above the tuyere. | Nitrogen. | Carbonic Acid. | Carbonic Oxide. | Light Carbut. Hydrogen. | Hydrogen. |
|---|---|---|---|---|---|
| 23 | 64.43 | 22.20 | 8.04 | 3.87 | 1.46 |
| 20½ | 62.65 | 18.21 | 15.33 | 1.28 | 2.53 |
| 18 | 63.20 | 12.45 | 18.57 | 1.27 | 4.51 |
| 15½ | 64.28 | 4.27 | 29.17 | 1.23 | 1.05 |
| 13 | 66.12 | 8.50 | 20.28 | 1.18 | 3.92 |
| 10 | 64.97 | 5.69 | 26.38 | 0.00 | 2.96 |

The ninth analysis of the Alfreton gases shows the composition at 2 feet 9 inches above the tuyere and 6 feet above the hearth stone. The gases from this furnace are calculated by weight, those of the Baerum furnace by volume The composition, by weight, of the gases escaping from the lat

ter furnace is Nitrogen, 58.95. Carbonic acid, 31.68. Carbonic oxide, 7.28. Carburetted hydrogen, 2.00. Hydrogen, 0.09.

### COMPOSITION OF THE LIQUID PRODUCTS OF THE FURNACE.

The composition by analysis of the liquid matter deposited in the hearth will vary with the composition of the solids entering at the throat, the volume of blast, and the completeness of the combustion.

#### CINDER.

With an excess of metal and earthy base for the carbon and flux consumed, the furnace produces what is technically termed "scouring cinder," containing a considerable quantity of metallic iron. A cinder of this description produced at one of the Dowlais furnaces, carrying a heavy burden of calcined argillaceous ore, gave by analysis:

| | |
|---|---|
| Silica | 38.00 |
| Lime | 26.38 |
| Alumina | 15.56 |
| Peroxide of Iron | 20.10 |
| Sulphur | traces |
| Manganese | " |

Metallic Iron, 14 per cent.

This cinder was of a dense black color, glazed on the surface, but of a crystallized structure within. Exposed to the atmosphere, the metallic iron in the surface was rapidly oxidized. Under more unfavorable conditions the per-centage of iron rises as high as 20 per cent., and the fractured cinder presents a lustrous black-lead appearance.

With an increased consumption of carbon and lime the per-centage of metal decreases, the cinder is more porous, and less black in color; when analyzed the composition is:

| | |
|---|---|
| Silica | 40.18 |
| Lime | 32.18 |
| Alumina | 11.68 |
| Peroxide of Iron | 15.04 |
| Sulphur | trace |
| Manganese | " |

Metallic Iron, 10.5 per cent.

By augmenting the proportion of carbon and flux, the per-centage of metal is still further reduced; the color is whitish gray, and well glazed on the surface. Composition as follows:

| | |
|---|---|
| Silica | 40.54 |
| Lime | 35.44 |
| Alumina | 14.06 |
| Peroxide of Iron | 10.04 |
| Sulphur and Manganese | traces |

Metallic Iron, 7.0 per cent.

A further addition of lime and carbon results in the production of a gray cinder, void of the glazed surface, containing nearly the same quantity of metal, and exhibiting an excess of lime.

### CRUDE IRON.

The crude iron obtained from the lower hearth ordinarily contains 95 per cent. of metallic iron, but under peculiar circumstances the yield may not exceed 90. The matters in alloy consist of carbon, silicium, aluminium, manganesium, magnesium calcium, sulphur, and phosphorus. With the cinder first described, the crude iron (cold blast) was white, and of a very inferior quality. By analysis its composition was nearly as follows:

| | |
|---|---|
| Iron | 94.96 |
| Carbon | 2.23 |
| Silicium | 1.94 |
| Aluminium | .86 |
| Phosphorus | traces |
| Sulphur | " |

With the second cinder the crude iron was white, but of a better quality for manufacturing purposes, being capable of conversion into malleable bars of considerable tenacity.

| | |
|---|---|
| Iron | 95.26 |
| Carbon | 2.63 |
| Silicium | 1.38 |
| Aluminium | .73 |
| Sulphur | traces |
| Phosphorus | " |

The crude iron produced with the third cinder was of a superior dark gray quality, ranking as No. 1 foundry iron.

| | |
|---|---|
| Iron | 95.20 |
| Carbon | 3.56 |
| Silicium | .82 |
| Aluminium | .42 |
| Sulphur | traces |
| Phosphorus | " |

The analysis by Dr. Thomson of a cold blast, No. 1 foundry iron, smelted from rich carbonaceous ores at the Muirkirk Furnaces, Scotland, gave:

| | |
|---|---|
| Iron | 90.98 |
| Carbon | 7.40 |
| Silicium | .46 |
| Aluminium | .48 |

Crude iron from the Carron Furnaces, in the hands of the same analyst yielded:

| | |
|---|---|
| Iron | 90.010 |
| Maganesium | .626 |
| Carbon | 3.086 |
| Silicium | 1.006 |
| Aluminium | 1.082 |

The conclusions which we have drawn from these and other analyses may be briefly stated thus:—

For the production of cinder, containing a minimum per-centage of metallic iron, the lime in the materials charged requires to be in nearly the same proportion as the silica; when it is greatly inferior, the cinder contains a large quantity of iron.

The lime is revived in the cinder, but of the sulphur, phosphorus, alumina and silica, a portion combines with the metal, forming crude iron.

The per-centage of carbon in the crude iron of coal and coke furnaces, is mainly dependent on the consumption of carbon to the ton of liquid matter obtained from the furnace. Of the carbon consumed, nearly 2 per cent. is in combination with the metal, whether this be of a white or gray quality.

The carbon, silicium, aluminium, and manganesium exist in the crude iron in the same proportion to each other as in the mass of materials charged into the furnace.

The phosphorus of the ore, fuel and flux is obtained in the iron, but of the sulphur, the largest portion combines with the lime when this substance *is equal or in excess of the silica.*

(To be continued.)

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ART. VI.—PETROLOGY; OR, THE STUDY OF ROCKS.*—By Oscar M. Lieber, Geologist to State of S. C.

IN a science which occupies so large a field as does that of geology, we must hail with ardent welcome the arrival upon the arena of literature of every new work, which, owing to its own soundness and the high source of its origin, may be regarded as closing an epoch in the progressive history of the science. With such feelings of pleasure must we regard the last work of Professor Cotta of Freiberg:—"Die Gesteinslehre, Freiberg, 1855."

Scarcely did we have time to rejoice at the first comprehensive and practical work on metalliferous deposits:—"Die Lehre von den Erzlagerstaetten," when the fertile pen of the same author places before us an equally perfect book upon another, though allied subject, the study of rocks.

In this work, a volume of 255 pages, he first treats of general matters connected with the subject, definitions, minerals which form rocks, and other topics referring to the classification of the constituents of the earth's crust. He then enters upon the description of the individual rocks. These he divides into the following classes or groups:—1. Basaltic rocks; 2. Greenstones and Melaphyre; 3. Trachytes; 4. Porphyries; 5. Granites and Gneisses;

*Die Gesteinslehre von Bernhard Cotta, Freiberg, 1855. J. G. Engelhardt.

6. Micaschistose and associated rocks, as talcose and chloritic slates; 7. Argillaceous rocks; 8. Silicious rocks; 9. Calcarious and dolomitic rocks; 10. Gypsoid rocks; 11. This group embraces various distinct minerals which, from their bulky mode of occurrence, may be properly regarded as rocks, i. e. important constituents of the solid crust of our planet. Among them we find rocksalt, emery and ice, which latter in this instance is very properly enumerated among rocks. In the words of the author, p. 195, "it deserves to be received among the rocks owing to its invariable occurrence at the poles, and in high mountains, as solidly frozen snow and glaciers, as well as on account of the ice strata in the soil of Siberia."—The 12th group comprises ferruginous, or better, ferriferous rocks. Coals are treated in the 13th class, and rocks which owe their origin to the disintegration of others in the 14th.

In that portion of the volume which is devoted to special descriptions, we find that local varieties have never been permitted to occupy a greater space than their comparative unimportance would warrant. There is altogether a lucid and perspicuous arrangement apparent throughout, which, indeed, is as singularly characteristic of the writings of its author. All his literary productions seem to satisfy, by treating thoroughly of that which their title-page promises shall be dealt with. The reader feels grateful for the ease with which the writer removes every obscurity. An accurate tidiness, if I may thus be permitted to use the word, pervades these writings, even in the smallest minutiæ, which naturally imparts itself to the reader's mind, and arranges into a compact structure the scattered materials gathered from desultory observation and reading. A table for the determination of rocks enhances the practical value of the book.

Carrying out the thoughts of his friend, the great Humboldt, Cotta has won an imperishable name among geologists by making the science a less speculative one, and thus rendering it more practical, and bringing the knowledge of it correspondingly nearer perfection. There would seem to be much similarity of mental action perceptible in the works of these two men, though the one may have confined it more to a single undivided study.

But the writer of this article would not presume to review a work from the pen of an author, whose very name on the title-page is so ample a letter of recommendation. His desire is merely to call attention to the book with those in our country to whom the German tongue is intelligible. To them let him add another remark, though its importance be slight. The neat manner in which the volume is gotten up is certainly no objection to it, for the same reason that we would prefer to drink fine wine from a rich goblet than from a cracked earthen vessel.

## ART. VII.—WESTERN RAILROAD IRON WORKS.

Continued from page 141, vol. VI.

BEFORE proceeding with the statements of Prof. D. D. Owen relative to the iron ores of the Saline Coal and Manufacturing Company, it may be well to notice some facts relative to the manufacture of iron and the estimated cost in this region of Southern Illinois. If the estimates of the English Commissioner, Wilson, who made a careful examination of the iron manufacture of the United States in 1853, may be relied upon, as doubtless they may be, we have the following rates of cost of production in different regions:—

| | | | | | |
|---|---|---|---|---|---|
| 1. Housatonic dis., | charcoal | production | 10,000 | tons, cost per ton | $20 to 25 |
| 2. Hudson River " | anthracite | " | 80,000 | " " " | 18 to 20 |
| 3. Delaware Lehigh dis., | " | " | 120,000 | " " " | 16 to 18 |
| 4. Schuylkill, | " | " | 100,000 | " " " | 20 |
| 5. Susquehanna, | " | " | 120,000 | " " " | 15 to 18 |
| 6. Potomac | " char. & an. | " | 125,000 | " " " | 20 |
| 7. Ohio, Cumberland & Tenn. | char. | " | 150,000 | " " " | 20 |
| 8. Isolated works out of these dis., | " abt. | | 100,000 | | |

The estimates of the Saline Company based upon the facts contained in the portion of the report of Prof. Owen previously noticed, relative to their supply of coal and the facilities for obtaining it, and to the abundance of iron ores presented in the subsequent part of the same report, together with the prices arising under their present operations, set forth the following results. The estimate is made for the manufacture of rails, of which these are the details:—

Estimate for improvements required to make 15,000 tons of railroad bars, and of the profit of product per annum.

| | |
|---|---|
| Cost of 4 blast furnaces, $33,000 each - - - - - - | $132,000 |
| " 1 rolling mill - - - - - - - - | 148,000 |
| " houses for superintendent and foreman, and 50 ditto for operatives - - - - - - - - - - | 20,000 |
| | $300,000 |

Estimated cost to manufacture 18,750 tons of pig iron:

| | | | |
|---|---|---|---|
| 2½ tons of ore for ton of pig, $1, is | $2,50 per ton - - | | $46,875 |
| 100 bushels coal " " 3c. | 3,00 " - - | | 56,250 |
| ¼ ton limestone " " 60c. | 30 " - - | | 5,625 |
| Labor, salaries, etc. " " 2,50c. | 2,50 " - - | | 46,875 |
| Castings, hearth stone, fire brick, clay, sand, oil, tallow, packing, waste, &c. | 72 " - - | | 13,500 |
| Incidentals, embracing repairs in part, | 98 " - - | | 18,375 |
| | $10,00 | | $187,500 |

Estimate for converting the above 18,750 tons of pig into 15,000 tons of rails:

| | | | | |
|---|---|---|---|---|
| 60 bushels coal, 3c., is | $1,80 per ton - - - | $27,000 | | |
| Breaking, wheeling & weighing, | 25 per ton - - | 3,750 | | |
| Boiling, $5,60 per ton, | $5,60 " - - - | 84,000 | | |
| Shingling by hammer, $1,12 | | | | |
| Do by machine, 28 | 70 " - - | 10,500 | | |
| $1,40 | | | | |
| Muck rolling, | 76 " - - - | 11,400 | | |
| Shearing, piling & heating, | $1,06 " - - | 15,900 | | |
| Rolling, catching, hooking & straightening, | $1,35 " - - - | 20,250 | | |
| Sawing, trimming and straightening, | 70 " - - | 10,500 | | |
| Mill managers & clerks, | 50 " - - - | 7,500 | | |
| Steam engines, | 25 " - - | 3,750 | | |
| Laboring hands, | 60 " - - - | 9,000 | | |
| Bl'ksmith & millwrights | 20 " - - | 3,000 | | |
| Furnace repairs, firebrick and clay, | 25 " - - - | 3,750 | | |
| Renewing and trimming rolls, | 25 " - - | 3,750 | | |
| Wear and tear, incidentally, | $3,23 " - - - | 48,450 | | 262,500 |
| | $17,50 | | | $450,000 |
| 15,000 tons of rails will sell for $56 per ton - - | | | | 840,000 |
| Annual profit - - - - - - - - - | | | | 390,000 |

The following is a comparative estimate, taking the results of the workings of the furnaces, of the Crane Lehigh Company, to show that the estimated cost of production of pig iron, say $10 per ton, on the Company's property is full and ample.

| | | | | |
|---|---|---|---|---|
| The average cost of producing a ton of pig iron, by the Crane Iron Works, for six years - - - - | | | | $15,52 per ton. |
| Average cost of coal for same period, | $5,21 | | | |
| do. do. iron ore do. | 6,18 | 11,39 | | |
| Cost of 100 bushels coal at Saline, | $3,00 | | | |
| " 2½ tons of iron ore, | 2,50 | 5,50 - - | | 5,89 per ton. |
| Equals cost of one ton pig iron at Saline - - - - | | | | $9,63 |

This difference is made in coal and iron ore only.

Having estimated 100 bushels of coal, to do what 65 bushels of the same value, or percentage of carbon, does in England, no allowance has been made for saving in the construction and maintenance of furnaces, in hearth stones, fire brick, fire clay, wood, lumber, horses, horse feed, oil, tallow, etc., all of which cost less than in the Atlantic States.

The Crane Company commenced with a capital of $100,000, which has been increased by the earnings to $500,000, and its stock now commands a premium of from 80 to 90 per cent. The estimates for converting into railroad bars have been submitted to L. Worthington, Esq., proprietor of the Globe Iron

Works, and to Thos. Steele, Esq., president of Cincinnati Rolling Mill, Cincinnati, whose replies are subjoined:

CINCINNATI, Oct. 13, 1855.

GEO. E. SELLERS, Esq., *President.*

DEAR SIR:—I have examined the estimates submitted by you "for the conversion of Pig metal into wrought iron railway bars, and am of opinion, that they are in the main safe to rely upon. That is, that with the facilities and conveniences contemplated, the price ($17,50 per ton), will cover the cost of converting on the spot.

Yours respectfully,
L. WORTHINGTON.

I have examined the estimates referred to above, and concur in opinion with Mr. Worthington.
THOS. STEELE.
November, 26, 1855.

Professor Owen thus continues:

In this district of Hardin County, there is a belt of country two or three miles wide, ranging in a N. N. E. and S. S. W. curve through these townships, towards the mouth of Grand Pierre Creek, which is the northern extension of the great contemporaneous ferruginous belt situated between the Cumberland and Tennessee Rivers.

The ores of this region of Illinois have only recently attracted attention. But two furnaces have been established as yet in Hardin County for smelting this ore, the Martha and the Illinois. The former of these now belongs to the Saline Coal and Manufacturing Company.

The ore banks of these furnaces are situated on sections 2, 3, 11 and 12, T. 12, R. 8. Facts which have been disclosed, during the working of the ore banks of the Martha furnace, situated on sections 2 and 6, T. 12 R 8, have most fully confirmed an opinion which I have long entertained in regard to the origin of this ore, which has an important practical bearing on the question regarding the quantity and enduring supply of these ores of Hardin County.

It is well known throughout the corresponding iron regions of Kentucky, that the deposits are locally irregular as to the quantity; so much so, that until the ore banks are fairly opened, it is always unsafe to rely on the amount of ore which the ore bank will furnish, even if the surface indications are favorable. Still I had observed, in exploring this iron region of Kentucky, that there was, nevertheless, a remarkable uniformity in the bearing of the principal ore banks, and that the ore was invariably found on the declivity of hills which had a nucleus of sub-carboniferous limestone; and generally of those particular beds of that formation characterized by peculiar organic remains, viz: *Lithostrotion* (Stylina of Lesneuer) *Syringopora ramulosa* of gold.

That, moreover, in no single instance could the ore be traced into horizontal beds, interstratified with the limestone.

My reference deduced from these observed facts, was, that this ore had its origin in veins, fissures, or crevices traversing this limestone formation in determinate lines of fracture: that

the ore existed deep in the interior of the vein as specular oxide, passing downwards into magnetic oxide: that for a long period of time these iron-bearing crevices in the limestone were permeated by heated carbonated waters, which found a vent at the opening of the fissure, and poured over the edges of the adjacent underlying calcareous beds, mingling with the debris and talcis formed by the wear, disintegration, and chemical decomposition of the exposed ledges forming the walls of the fissure. That these mineral waters, charged as they were with carbonic acid, had a solvent power on the deep-seated iron ores, and brought the iron to the surface in solution as bicarbonate of the protoxide, in the form of strong chalybeate water, which, as it filtered through the chert gravel fallen out from the decaying limestone, and permeating the ferruginous clays and earths washed out from the crevices, joints and seams of the limestone, lost their carbonic acid, while the protoxide iron, combined therewith, gradually oxidized and consolidated in its passage down the declivity of the hill, and finally infiltrated ore banks such as we now see them, more or less rich, according to the copiousness of these ferruginous waters and the continuance of the chemical and mechanical action through a longer or a shorter period of time. When the chalybeate waters dripped slowly into vacant places, it produced the so called "pipe ore," a true ferruginous stalactite, analogous in form, though not in composition to the calcareous stalactite often seen pendant from the roofs of caves, and having their origin from dripping waters holding lime, instead of iron, in solution. When these chalybeate waters oozed through coarse, gravelly earths or lumpy clays, they often coated with concentric layers any siliceous or argillaceous nuclei intercepting its downward passage; and these produced the various forms of pot ore. Again, where it insinuates itself through porous earths, we find the honey-comb structure prevalent, and the interstices numerous and closely set.

Such being the process of formation, it is easy to see how, in ore banks usually opened on hill sides, where this process of infiltration has taken place with greater or less rapidity, and during longer or shorter periods of time, the amount of ore will be variable in quantity and various in structure; but if these secondary formations of iron ore can be traced to their origin in a vein of good dimensions, well filled with ore, then the amount of ore that can be obtained is almost unlimited.

While working ore banks of the Martha and Illinois furnaces on sections 2 and 3, T. 12, R. 8, the ore was followed until it headed between well defined walls of limestone. On these sections the ore has been found filling two distinct fissures running parallel to each other, with an uniform bearing of N. 15° E. On section 2 the width of the fissure was found to be twenty-four feet. Here the ore was followed to the depth of sixty or seventy feet, when, for the want of the necessary power to drain the accu-

mulated water, the working was discontinued. On section 3 the crevice measured from wall to wall twenty-seven and a half feet, and the ore has been followed to the depth of ninety feet. This fissure supplies the greater part of the ore smelted at the Illinois furnace. The surface deposits which supply the Martha furnace, are obtained over the crevice on section 34, T. 11, R. 8.

On the side of a hill lying to the N. E. of the ore-bearing crevice on section 2, ore banks have been opened and partially worked. Already the face of the walls of a crevice can be seen on the east. On taking the bearings across the valley, S. 15° W., these were found to coincide with a "prospect hole" sunk in a shallow ravine, having the same bearing as it rises the hill side where ore has also been discovered, and the same course leads over the brow of the ridge to a locality where abundance of fine pipe ore was obtained for the use of the Martha furnace.

Here, then, some 200 yards to the east of the crevice above described on section 2, is, in all probability, another parallel ore-bearing fissure.

The conclusion which I arrive at from these facts, is, that though individual ore banks on hill sides may fail in their yield, a thorough investigation will often lead to the detection of the source of the ore in regular fissures of the limestone, where a more uniform and abundant supply may be anticipated, and where it is more concentrated and less mixed with siliceous impurities and other extraneous matter.

Subordinate spurs, thrown off from this main mill stone-grit range, interlock with the lower hills of the iron region. These connecting spurs are composed usually of alternations of sandstone, limestone and shale, forming the transition series between the mill stone-grit proper and the massive limestones of the subcarboniferous group. These intercalated limestones are every where recognized by the presence of particular species of *Pentremites* and *Archimedes*, and a multitude of beautiful minute species of *Terebratula*, *Spirifer*, &c.

The true geological position of the ores I have just been describing, is beneath these intercalated masses of limestone, sandstones and shales, reposing on, or enclosed in, fissures of the more massive beds of limestone of the subcarboniferous group containing, as heretofore remarked, *Stylina*, *Syringopora*, along with *Bellerophon*, *Hiulcus*, and various curious forms of *Gorgonia* and *Retepora*.

These hydrated brown iron ores of the subcarboniferous limestone formation of Hardin County, Illinois, are essentially composed of water and peroxide of iron, with occasionally a small admixture of protoxide, and insoluble earthy silicates.

The analysis of an average specimen from the ore banks of the Martha furnace, having a specific gravity of 3.156, yielded:—

| | | |
|---|---|---|
| Water, | $H.$ = 10.8 | |
| Silicious earth, insoluble in hydrochl. acid, | 5.0 | |
| Peroxide of iron, | $Fe.$=80.0=56.02 | *Fe.* |
| Alumina, | $Al.$= 3.7 | |
| Loss, and alkalies not estimated | 0.5 | |
| | 100 | |

Giving the chemical formula of $Fe.\ 0+H.$
$2\ 3$

This ore, if economically worked in the furnace, should yield from 50 to 56 per cent. of metallic iron. The quality of iron produced from these hydrated oxides of iron is similar to the iron from the Cumberland and Tennessee Rivers, in Kentucky and Tennessee, and the Housatonic River in Connecticut.

The sub-carboniferous limestones of Hardin County are traversed by another system of fissures, bearing, as near as I have as yet been able to ascertain, N. 21 E., with cross veins N. 45° to 54° E. These veins are often very large, and contain as veinstone, fluor-spar, accompanying galena and blende.

The localities where I had an opportunity of examining this system of fissures are situated on section 9, T. 11, R. 8, and section 32, T. 13, R. 8, on a 40 acre tract entered by Casey, adjoining Abraham Womack's, and at Lead Hill, on section 4, T. 12, R. 9. These metallic veins have been very partially explored, in a rude way, and penetrated to the depth of 30 to 60 feet, but without any very satisfactory result. The existence of lead has, however, been fully demonstrated, some of which contains as much as $\frac{1}{100}$ parts of silver, or about two pounds to the ton.

These mining operations have, I believe, not been very successful, partly on account of the presence of zinc in connection with the ore in the vein; but it does not by any means follow that these veins may not be worked to profit and advantage; for the mining operations have been altogether too superficial and unsystematic to prove the veins, and they have been uniformly worked by men without capital, and generally with little or no experience in mining operations. One thing, however, is certain, that these veins are very analogous in their character to the lead veins of Derbyshire, England, where the lead ore occurs in the same geological formation, and the ore is accompanied by the same veinstone—fluor-spar. Again, it is a well known fact in the annals of mining, that metallic veins seldom prove productive within several hundred feet of the "*grass.*"

Some of the crystallized specimens of fluor-spar which these veins yield, even within a few feet of the subsoil, are magnificent; these rather furnish a guarantee for the purity of the metallic ores occurring in the same vein.

On the whole, it is believed that these mines might be made profitable by a judicious and systematic course of mining and smelting, with a sufficient capital at command; the three as-

sociate metals, lead, zinc and silver, being simultaneously reduced and prepared for market.

Another system of veins traverse these same limestones, N. 71° to 72° W.; these are chiefly filled with calcspar. They vary from a few inches to three feet and more in width. These veins have also yielded some lead ore; but less is known in regard to them than the fluor-spar veins.

Passing from Turkey creek, on the Company's property, on the south side of the Saline, towards the mouth of Eagle creek, you descend most of the distance on a line of dip of the same group of coal measures which occupy the ridges between the Woodward and Chamberlin mines, until, at the crossing of Eagle creek, the Anvil Rock is seen in the bank of that stream. Soon after crossing Eagle creek, a considerable stretch of post oak flats intervene, beyond which you reach the continuation of the strata composing Gold Hill, which limit the coal measures in this direction.

Near the Island Riffle, the millstone grit appears in full force, in ridges of considerable altitude. At the foot of this range is the Salt spring, which you were desirous to have me examine. On critically investigating its geological position, I discovered that it is situated within a few yards of a remarkable fault, which here brings ledges of the sub-carboniferous limestone abruptly to the surface, in juxtaposition with the millstone grit, and only a few yards from the fountain head of the brine spring.

There can be no doubt that this locality would be a favorable situation for attaining, by boring, a strong brine, within a moderate distance of the surface; but it is too far removed from the present coal mines to be manufactured into salt by the slack and refuse coal which they supply.

There is, in the immediate neighborhood of the coal mines, sufficient evidence of the existence of salt-bearing rocks, within 800 or 1,200 feet of the surface, to justify the expense of boring after salt water, which, if obtained, could be manufactured to great advantage in connection with the coal business. A point somewhere near to where the mill road crosses the railroad, where Mr. Halloway has noticed gaseous exhalations emitted, would probably be as good a point to make the trial as any place near the mines. From the greater abruptness of the rise of the strata, after leaving the south side of the Saline, in the direction of the millstone grit range, I am led to suspect the existence of a trough, if not a fault, in the stratification, which would arrest the filtration of waters along the course of the dip, to the N. E. At any rate, it would not be an expensive work to test the inference, by boring 1,000 or 1,200 feet, which, if successful, would be a great source of profit. Besides, there is reason to believe that a greater thickness of salt-bearing rocks would be passed through near the mines, than at the Island Riffle;

so that, if the synclinal axis of the strata is of a form favorable for the retention of water, more lasting sources of brine may be expected in this part of the valley of the Saline.

While exploring the Brinkley branch of Eagle creek, I had an opportunity of examining the Woodward Spring, at the fountain head, and filling two bottles with water. Since my return, I have tested this water, as far as the quantity at my disposal would allow, for those fixed ingredients which had not escaped in the interval which had elapsed between collecting at the spring, and opening at my laboratory.

I found it to contain, in 16 ounces, 0.125 grammes of solid saline matter, which is exactly 1 gramme, or 15.44 grains in one gallon.

The principal constituents I find to be:

| | |
|---|---|
| Carbonic acid, | Sulphuric acid, |
| Chlorine, | Oxide of iron, |
| Lime, | Magnesia. |
| Soda, | |

When first opened, and tested with re-agent papers, it showed a feeble acid reaction; but after being boiled some time, so as to expel free carbonic acid, the alkaline reaction is very apparent, owing to the formation of a sub-carbonate of soda. Operating on eight ounces, I obtained, by concentration and separation of most of the earthy ingredients, a feeble reaction, indicative of the presence of bromine. There appears to be also a small portion of an organic principle present, probably the crenic or apocrenic acids.

An approximate quantitative analysis of the principal fixed ingredients from 16 ounces of the water gave:

| | |
|---|---|
| Earthy matter insoluble in weak nitric acid, | 0.0020 |
| Carbonic acid, (estimated from loss,) | 0.0333 |
| Sulphuric acid, | 0.0240 |
| Chlorine, | 0.0013 |
| Bromine, | a trace |
| Lime, | 0.0341 |
| Oxide of Iron,* | 0.0006 |
| Magnesia, | 0.0160 |
| Soda, | 0.0137 |
| Crenic, | a trace |
| | 0.1250 |

The medical effect of the spring will be that of a tonic, anti-periodic, and a corrector of acid productions in the system. In this way, it may often prove highly beneficial to invalids; especially to those debilitated by chronic intermittents.

* The greater part of the oxide of iron is deposited as a brown gelatinous mass at the spring, as soon as the water reaches the atmosphere, and is relieved from pressure.

Near the base of the millstone grit range, on the waters of Grand Pierre creek, I examined a locality of potter's clay derived from the disintegration of the purer shales, interposed between the millstone grits and the intercalated limestones which succeed beneath; the same bed outcrops on the Ohio River, on the company's property. The bed is three or four feet thick where it is exposed, and though not perfectly free from oxide of iron, is so nearly so that it will answer for making the yellow Rockingham ware, and the purest parts might even be suitable for the ordinary white queensware. From information obtained since my return from the survey of Hardin County, I have reason to believe that the same material will be found on the Martha furnace property, and not far from the Ohio River. It is a material of similar appearance to the porcelain earths found below Cape Girardeau and elsewhere, in Missouri, which produces a self-glazing ware that can hardly be distinguished from the "*marble-ware*" now much in vogue, except that it is rather more unctious to the touch, and more adhesive to the tongue. I have specimens of this self-glazing ware, made from the native material, taken from a bed on the property of R. D. Owen & Bro., on the Mississippi River, a few miles below Cape Girardeau.

On the map accompanying this report, the general outline marking the boundaries between the productive coal measures and the millstone grit range, is indicated as far as the survey was extended; also, the boundary between this latter range and the underlying limestones.

Particular localities of outcrop of coals are indicated by C.; millstone grit, by M. G.; conglomerate by Cong.; intercalations of sandstone and limestone, by S.C.L.; localities of iron, by Fe.; of lead, by Pb.; of Zinc, by Zn.; fluor-spar, by Ca. F.; calcspar, by Ca.C.

While summing up, in conclusion, a few of the various mineral resources of this part of Illinois, permit me at the same time, to call your attention to some of the advantages and facilities which the location of the lands of the Saline Coal & Manufacturing Company may lay claim to, for mining and manufacturing purposes.

It would be difficult to find a location in the United States where so many workable beds of coal are concentrated in a limited space, as in this southern part of the middle coal field of the Mississippi valley, adjacent to the Ohio River, five beds making their outcrop, from the summit of the bluff to low water; and three to four more beds can be won in the mile space intervening between the valley of the Saline and the Dutton cliff.

The quality of the coals generally, proves to be equal to any coals mined adjacent to the Ohio River, below Pittsburg, and superior to any coals I have yet examined from the Mississippi or Missouri Rivers.

The shales intercalated with the coal measures, are often rich in iron-stones, capable of producing about 30 to 40 per cent. of excellent, soft, gray iron, of much tenacity, and well adapted for conversion into steel.

The slack and waste coal can be employed in the manufacture of salt, if not immediately at the mines, within a few miles of them.

The coal lands lie from ten to twelve miles north-east of the extensive iron region of the subcarboniferous limestone formation, affording abundance of the hydrated brown oxide of iron, which will yield from 50 to 56 per cent. of good malleable iron.

Almost every coal reposes on a bed of fire-clay, which will afford an abundant supply of this material so useful in manufacturing districts.

The dark limestone which locally overlies the upper coal, is capable of receiving a good polish, and forms a beautiful black marble, where the rock is veined and free from imperfections.

An ample source of limestone for fluxing ores and other purposes, can be obtained, either from the above-mentioned bed of limestone, over the upper coal, from the ferruginous calcareous rock, which crops out under the 4-inch coal in Round-hill branch, or from the hills on the south side of the Saline, below the Saw-mill, where a bed of limestone, equivalent to the Curlew limestone, can be found.

As all the bulky materials required for the use of potteries, can be found close at hand, in the coal measures of the Saline, this vicinity would be a very favorable position for the establishment of such works, especially since, for certain kinds of queensware and porcelain, materials can be obtained within convenient distance.

The Shawneetown uplift, which is but seven miles north of the mouth of the Saline, has cast up the conglomerate and mill-stone grit, and thus cut off, in a north-easterly course, the productive coal measures of the Saline, underlying the anvil rock.

Up stream, beyond this axis of elevation, which crosses the bed of the Ohio River opposite Shawneetown, these coal measures are no longer accessible, but by deep shafting.

It is true that a contemporaneous zone of carboniferous strata rise again between Rockport and the Cannelton coal mines; but so far as we are yet acquainted with these equivalent coal measures on the north-eastern margin of the middle coal field, the beds of coal are thinner, and also deeper seated, by reason of an extensive fault of sixty feet, immediately south of the Trabue mines.

When we consider, at the same time, their increased distance, by over two hundred miles from the down stream markets, it appears evident that they can hardly come into competition with the south-western coal mines.

I may add, that I know of no coal locations on the intermediate higher coal measures, *adjacent to the Ohio River*, that can compare in accessibility and concentration of mineral wealth, to the 260 feet of strata described in this report, underlying the anvil rock. Indeed, if we take the whole range of the middle coal field, occupying the greater part of Illinois, the western part of Indiana, and the north-western part of Kentucky, we cannot find a locality, at present known, where good coal can be worked to as great an advantage and profit, as south-west of the Shawneetown disturbance, and more especially, none which is so favorably situated for supplying the southern markets. Since from Battery Rock, in Illinois, the coal measures recede from the Ohio River, with a strike line curving to the north-west, through Pope, Johnston and Williamson Counties, towards the south bend of big Muddy, below its forks in Jackson County, so that no coal mine can be opened within a reasonable distance of the Ohio River, below this point.

Battery Rock, on the Illinois side, and the mouth of Tradewater, on the Kentucky shore, may therefore be regarded as the termination, in a south and west direction, of the productive coal measures of the middle coal field on the Ohio River. Hence coal mines situated on, or adjacent to this part of that river, command the markets of the south, under more advantageous circumstances than those above them on that stream, or up the Mississippi and Missouri Rivers, especially in the winter season, when coal is most in demand, and in low stages of water.

I need hardly allude to the great advantages which, in times of freshets and floating ice, the basin of the Saline affords, as a safe harbor for coal boats, which can be loaded here in still water, within a short distance of the coal entries, though when an extensive business is carried on, such as these mines demand and amply justify, it will be found advisable to have, besides, a continuous line of railroad to the Ohio River, having its terminus, as is proposed, at or near the mouth of Little-cane creek, so as to be independent of all delays or casualties which might occur in shipments by way of the Saline.

The position of the main or five feet bed of coal, entirely above the reach of highwater, with two workable beds still above, prevents the necessity, at present, of sinking shafts, unless it should be deemed advisable to do so, to win the three and four feet coals, near to the present openings.

These last, with all the lower seams, are accessible in this property, above high water, but at some distance from the present railroad and improvements.

As far as the entries have been driven into the coal, the galleries are dry and comfortable. The roof is a solid black bituminous shale, locally enclosing, here and there, large hemispherical balls, mostly of a pyritiferous character.

If ever the luxuriant primitive forest should fail to supply the timber necessary for the production of charcoal, to reduce the ores that may be worked, a supply of coal is at hand to take its place, which thousands of years cannot exhaust.

These native woods will also furnish a convenient and abundant supply of the various kinds of timber, suitable for building purposes, for coal boats, and all other constructions.

The workshops, already built, for the construction of boiler-iron coal cars, and other implements and utensils required for the mines, I found to be spacious, convenient and well appointed. Indeed, the improvements generally are of a permanent and substantial character. The miners' dwellings are large, comfortable and neatly arranged, in what is intended to be a wood's pasture, which, of all rural American features, contributes, perhaps, most to the beauty and attraction of our forest homes.

The soil of the country, especially on the long and gentle easterly slopes, conformable with the dip of the coal measures, and in the rich bottoms, is highly productive, capable of supplying all mines and manufactures which may be established with farming produce of every description, suitable to the climate and latitude, at very reasonable rates; indeed, it is probable that the rich, black, deep prairie land of Illinois, lying to the north of the mines, can compete with any part of the world, in the production of many of the staple articles of consumption.

Such are a few of the manifold advantages which occur to me at this time, and which will be fully appreciated by all business men acquainted with the coal trade.

(To be continued.)

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## JOURNAL OF MINING LAWS AND REGULATIONS.

### THE RIGHT TO DRAIN MINES.

We have now the decision of the Supreme Court of Pennsylvania on an appeal in the case of Baugh *vs.* Wheatley, stated in full on page 386, vol. 4, of this Magazine. It is a most important decision to owners of mineral property in Pennsylvania, and will doubtless become hereafter the basis of decisions in other States;

Charles M. Wheatley *vs.* Jacob Baugh, *Error to Common Pleas of Chester County.*

Lewis, C. J.—A mining company, in the course of necessary operation in mining minerals from their own land, interrupted the percolations which supplied a spring on an adjacent tract, and the owner of the spring, under the direction of the Court below, recovered damages for the loss of it. The question is, can this recovery be sustained?

The general principle undoubtedly is, that he who owns the soil has it even to the sky, and to the lowest depth. He may dig as deep and build as high as he pleases. The maxim which embodies the principle is "*cujus est solum ejus est usque ad coelum et ab inferas.*" If this general rule be applicable to the case before us, the plaintiff in error is justified in all that he did on the land of the principals by their direction. But there are some restrictions upon this general right of property, which it becomes necessary to notice. The natural streams of water existing by the bounty of Providence, for the benefit of the land through which they flow, are incidents annexed to the land itself. 4 Mason, 400; 12 Wend. 332. They do not begin by consent of parties, nor by perscription, but *ex jure naturæ*, and therefore they are not extinguished by unity; nor can they be obstructed or diverted to the prejudice of adjacent proprietors. Surry *vs.* Piggot, Popham, 170; 3 Bulst. 339.

It was said by Sir John Leach, in Wright *vs.* Howard, (1 Sim. & Stuart ,190,) that "every proprietor who claims a right either to throw the water back above or to diminish the quantity which is to descend below, must, in order to maintain his claim, either prove an actual grant or license from the proprietors affected by his operations, or must prove an uninterrupted enjoyment of twenty years." (Sim. & Stuart, 190.) It is true that there is a difference between water courses on the surface, and those which run under ground, (Acton *vs.* Blundell, 12 Mees & Wells, 324.) But that distinction does not authorize neighboring proprietors to disregard the necessities of each other's condition in respect to the latter. It is manifest that valuable rights may exist in both; and it is indisputable that wherever they do exist, they must be protected by law. In limestone regions streams of great volume and power pursue their subterranean courses for great distances, and then emerge from their caverns, furnishing power for machinery of every description, or supplying towns and settlements with water for all the purposes of life. To say that these streams might be obstructed or diverted, merely because they run through subterranean channels, is to forget the rights and duties of man in relation to flowing water. But to entitle a stream to the consideration of the law, it is certainly necessary that it be a *watercourse*, in the proper sense of the term. A spring gutter on the surface is none the less a watercourse although it is not equal in volume to a river. Small as it may be, if it have a clear and well-defined channel, and a regular flow in that channel, it cannot be diverted to the injury of the proprietors below. (Jack *vs.* Martin, 12 Wend. 330.) So, a subterranean stream, which supplies a spring with water cannot be diverted by the proprietor above, for the mere purpose of appropriating the water to his own use. (Smith *vs.* Adams, 6 Paige, 435.) As the owner of the land below is bound to permit the stream to flow in its accustomed channel, and cannot erect obstructions so as to throw the water back on his neighbor above, so the latter is bound as a correlative obligation to permit it to flow to his neighbor below. Each has a right to a reasonable use of the water on his own premises, but he must so exercise his privilege as not to injure the rights of the other. "*Sic utere tuo ut alienum non lædas,*" is the maxim especially applicable to the enjoyment of these rights. When the filtrations are gathered into sufficient volume to have an appreciable value, and to flow in a clearly defined channel, it is generally possible to see it and to avoid diverting it, without serious detriment to the owner of the land through which it flows. But percolations spread in every direction through the earth, and it is impossible to avoid disturbing them without relinquishing the necessary enjoyment of the land. Accordingly the law has never gone so far as to recognize in one man a right to convert another's farm to his own use, for the purposes of a filter. Such a claim, if sustained, would amount to a total abrogation of the right of property. No man could dig a cellar, or a well, or build a house on his own land, because these operations necessarily interrupt the filtrations through the earth. Nor could he cut down the forest and clear his land for the purposes of husbandry, because the evaporation which would be caused by exposing the soil to the sun and air would inevitably diminish, to some extent, the supply of water which

would otherwise filter through it. He could not even turn a furrow for agricultural purposes, because this would partially produce the same result. Even if this right were admitted to exist, the difficulty in ascertaining the fact of its violation, as well as the extent of it, would be insurmountable.

The Roman law, founded upon an enlightened consideration of the rights of property, declared that "he who in making a new work upon his own estate, uses his right without trespassing either against any law, custom, title or possession which may subject him to any service towards his neighbors, is not answerable for the damage which they may chance to sustain thereby, unless it be that he made that change merely with a view to hurt others without any advantage to himself." "He may raise his house as high as he pleases, although by the elevation he should darken the lights of his neighbor's house." Domat, 3, 1047. He may dig for water on his own ground, and if he should thereby drain a well or spring in his neighbor's ground, he would be liable to no action of damages on that score. Domat, 8, 1581. Pardessus Tract des Servitudes, s. 76. Dig. 39, 2, 24, 12 &c. These principles of the civil law are also the recognized doctrines of the common law. Bury *vs.* Pope, 1 Cro. Eliz. 118, Parker *vs.* Foote, 19 Wend. 309, Hay *vs.* Sterret, 2 Watts 331; Greenleaf *vs.* Francis, 18 Pick. 121; Acton *vs.* Blundell, 12 Mees and Wells, 324. It is true that several English *Nisi Prius* decisions introduced a modern doctrine in relation to ancient rights in opposition to that held in the reign of Queen Elizabeth, by all the Judges in the Exchequer Chamber. 1 Cro. Eliz. 118. But the modern doctrine was never recognized by the King's Bench until the decision in Darwin *vs.* Upton, in 1786, 2 Saund. 175 note 2. As that decision was since the American Revolution, after which English Courts ceased to have authority here, and is an anomaly in the law, the modern doctrine founded upon it has not been received as suitable to the condition of this country. 19 Wend. 309, 2 Watts, 331.

In Acton *vs.* Blundell it was held that the defendant had a right to sink coal-pits on his own land, although he thereby drained a well on the plaintiff's land. In Greenleaf *vs.* Francis, it was decided that the owner of land may dig a well on any part of it, notwithstanding he thereby diminishes the water in his neighbor's well, unless in doing so he is actuated by a mere malicious intent to deprive his neighbor of the water without benefit to himself. 18 Pick. 117. Neither the civil law nor the common law permits a man to be deprived of a well, or spring, or stream of water for the mere gratification of malice. The reason is, that water, like air, is of such a nature that no one can have an exclusive right to it. In the process of evaporation and condensation it is sent in refreshing showers all over the earth. In its descent to the ocean it necessarily passes from one to the other, and it is intended for the benefit of all. The right of each is more or less dependent upon that of his neighbor. In this description of property it is, therefore, peculiarly necessary that each should be mindful of the necessities and rights of the others. The owner of land on which a spring issues from the earth has a perfect right to it against all the world, except those through whose land it comes. He has even a right to it, as against them, until it comes in conflict with the enjoyment of their own property. Strangers cannot destroy it, even though it be derived from lands which do not belong to the owner of the spring. Even a railroad corporation, armed by law with the eminent domain, and having power to take private property for the construction of its road, is answerable to the owner of a spring for destroying it, although its destruction be caused by excavations on the land of an adjacent proprietor. (Parker *vs.* The Boston and Maine Railroad Co., 3 Cush. Rep. 107.) But while the Court in that case held that the Corporation was liable, on the ground that the destruction of the spring was not required for the purposes of the owner of the land through which the excavation was made, the principle was fully recognized that each proprietor has a right to make a proper use of his own land, and that sinking a well upon it is such proper use; and if the water, by its natural current, flows from one to the other and a loss arises, it is *damnum absque injuria*. (Parker

*vs.* The Boston and Maine Railroad, 8 Cushing's Rep. 107; 1 American Railway Cases, 553.)

The prior occupancy of the spring for the uses of a tannery, gave no rights of servitude over or through the land of the adjacent proprietor. No man, by mere prior enjoyment of the advantages of his own land, can establish a servitude upon the land of another. This is shown in a satisfactory manner by Mr. Justice Rogers, in Hoy *vs.* Sterret. 2 W. 330. But it seems to be thought that the enjoyment of the spring by the plaintiff below and those under whom he claims, for the period of twenty-one years, gives him a right to its continued existence—although the neighboring proprietor may thereby be deprived of the chief value of his own land. This depends upon the question, whether the enjoyment of the spring was of such a character as to have invaded his neighbor's rights, so as to enable him to maintain an action for the injury. No man can be barred by a statute of limitation for not bringing his action within the prescribed period, until it be first shown that he had a cause of action which he could have maintained.

In analogy to the statute, no presumption can arise against a party on the ground of long enjoyment of a privilege by another, until it be shown that the privilege in some measure interfered with the rights of the party whose grant is proposed to be presumed, and that he had a legal right to prevent such enjoyment by proceedings at law. Presumption is, when the conduct of the party out of possession cannot be accounted for without presuming a conveyance. Kingston *vs.* Lesley, 10 S. & R., 390. Baty *vs.* Ihrie, 1 Rawle, 218. The Frederician code of Prussia provides that no presumption can take place where no negligence can be imputed, and accordingly by that code a man may raise his house after any lapse of time, although it darkens his neighbor's house. Frederician code of Prussia, 48, 505. The same principle is to be found in the law of Scotland. Erskine's Prin. Law of Scotland, 350. The owner of the house had no right to complain of his neighbor below for making use of the spring on his own land. As long as it flowed there he had a right to make use of it, and the owner of the land, through which the supply of water came, was not in any manner injured by such use of the water. Silence, or acquiescence, where one is not injured, and has no cause of complaint, can never deprive him of his rights on the ground of presumption of a grant. No man can be said to have granted a right about which it would have been an impertinent interference to utter a complaint. Hoy *vs.* Sterret, 2 Watts, 331; Merlin's Repertoire de Jurisp. Verb. *cours d'eau.* Besides, it was impossible for him to know from whence the supply of water came. He had no knowledge that it was derived from percolations through his own land. In this respect there is a material difference between hidden veins of water under the ground and watercourses flowing on the surface. The latter are apparent, and if appropriated in such a way as to injure the rights of the owner, through whose lands they flow, he can take cognizance of the wrong, and is bound to redress it by an action within the period prescribed by law. But the former are not apparent, and the owner of the land is not bound to resort to an action to redress a wrong of which he cannot by any possibility have notice. By the civil code of Louisiana *non apparent servitudes* can be established only by *title.* Immemorial possession alone is not sufficient to acquire them. Civil Code Louisiana, tit. Servitudes, p. 240. See also Pardessus, Trait de Servitudes, s. 95. In a case like the present, therefore, there is no ground whatever for depriving the plaintiff in error of the enjoyment of his rights of property on his own land, on the ground of any servitude established by time or acquiescence, for the benefit of the tannery or the adjacent tract.

We have treated the spring as depending upon percolations alone, at the point where the mining operations were carried on; because the evidence does not show that any distinct watercourse leading to it has been cut off or diverted. If this should be shown, and it should also appear that it could have been preserved without material detriment to the owner of the land through which it flowed, the destruction of it might be attributed to malice or

negligence. In that case the law would furnish redress, because the injury would be unjustifiable. The Beneficent Being who created the earth, and gave man dominion over it, imposed on him the duty of doing to others as he would that they should do to him. Upon this high moral obligation rests the legal one, which requires every one so to use his own privileges as not to injure the rights of others.

In all the relations of social life, it is the interest and duty of each to respect the privileges of others, The law which requires this, "acts with a reasonable reference to the public convenience and general good, and is not betrayed into narrow strictures subversive of common sense, nor into extravagant looseness which would destroy private rights." Tyler *vs.* Wilkinson, 4 Mason U. S. Rep., 397. In determining what is reasonable, the circumstances of each case must be carefully considered, and the jury, under the instructions of the Court, must in general decide the question. Hetrich *vs.* Deachbler, 6 Barr., 32; Miller *vs.* Miller, 9 Barr., 74. The owner of a spring, although his right is imperfect where his supply is derived through his neighbor's land, has nevertheless a privilege subordinate only to the paramount rights of such neighbor; and it is only when the fair enjoyment of these paramount rights require its destruction that he is bound to submit to the deprivation. In conducting extensive mining operations, it is in general impossible to preserve the flow of the subterranean waters through the interstices in which they have usually passed, and many springs must necessarily be destroyed in order that the proprietors of valuable minerals may enjoy their own. The public interest is greatly promoted by protecting this right, and it is just that the imperfect right and lesser advantage should give place to that which is perfect and infinitely the most beneficial to individuals and the community in general.

There was no evidence to justify the jury in presuming a grant of a servitude; nor was there any testimony tending to show either malice or negligence in conducting the mining operations. There was nothing to show that the Mining Company had been guilty of any thing beyond the proper use of their own property. The plaintiff below had therefore no cause of action, and the jury ought to have been so instructed.

Judgment reversed, and *venire facias de novo* awarded.

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### SLOOP CARGOES OF COAL.

A cargo of coal was sold by one party to another in New York city, both well known, and by the recipient discharged, who finding it short, refused to pay the full amount of freight demanded, suit for which was accordingly brought. Verdict has been given for the plaintiff in the lower court, as had been previously done in similar cases. The defendant, however, carried up the case to the higher court, where it was tried in October last, before Hon. D. P. Ingraham—first Judge—and the following is a *verbatim* copy of his opinion and decision—settling and establishing the law in the premises.

"A bill of lading signed by the captain is evidence that the goods therein stated have been received on board of the vessel, and cannot be altered by parol evidence. No such evidence was offered in this case, and the plaintiff, as assignee of the bill of lading, *was justified in demanding the quantity of coal as stated therein.*

But I think the justice erred in holding the defendant liable for all the freight—he was the mere assignee of the bill of lading—as such he was *not liable for any freight except of the goods he received.*

It is undisputed that all the coal was not delivered; still the court below has held the defendant liable for the freight of coal not delivered, although it was demanded by him, and a part was not delivered. Even if the original consignee could be made liable, which is *not admitted*, still there can be no doubt that no such liability exists on the part of the assignee, who has not received the property. His liability only extends to the property *actually received by*

*him*—6 Cow. 504—Abbot on shipping, 421—Hindsell *vs.* Weed—5 Denio, 176. If at any subsequent period the master was ready to deliver the residue of the coal, he should have notified the defendant; by so doing, he might have avoided liability for the portion of the cargo not delivered.

*I am at a loss to see upon what ground the plaintiff can be relieved from the liability he incurred from not delivering the balance.* The bill of lading admitted the receipt of it—while in process of delivery, he refused to deliver the balance remaining after the owner had demanded it, alleging that it was not on board, and that he could not deliver what was not on board at the time it was demanded; no subsequent offer to deliver was made, and the balance has never been received by the purchaser.

These facts are sufficient to establish at law a *prima facie* case in favor of the defendant.

The defendant, it is to be remembered, is the purchaser of the property from the consignee, and has relied upon the bill of lading in making his purchase. He is not bound to accept from the master, property of a *different kind* from that which the bill of lading describes.

It is said, there was a waiver on the part of the defendant when he received a portion of the coal, after he was informed it was not all on board.

There could be no waiver in taking all he could get of his property. He had a right to do so, and hold the carrier responsible for the balance.

The judgment must be reversed."

*Decision.*—"An assignee of a bill of lading is only liable for freight on the goods received by him.

Where a bill of lading for coal describes it differently from the cargo placed on board, and a third person purchased the coal according to the bill of lading and took an assignment thereof, he had a right to insist upon a delivery of the coal, according to the bill of lading, and in case of not delivering, the carrier was liable.

Receiving a part was no waiver of the right to demand the residue according to the bill of lading."

The above decision is as strong and as comprehensive as it could possibly be. From its provisions, we see that the captain is bound to deliver, and is responsible to the consignee for all that coal which he signs for in the bill of lading—the consignee has the right to deduct from the amount of freight the value of all deficiencies. Moreover, the consignee has a right to demand the kind of coal specified in the bill of lading, and is not bound to receive, for instance: Stove in place of Egg, or *vice versa*, having the privilege of insisting fully upon not only the quantity, but the specific kind of coal mentioned in the bill of lading, and may hold the carrier fully responsible, being supported in his positions by the higher decisions of the law.

We may also state, that it is not necessary that the coal should be weighed upon the deck even, but that the evidence of a clerk or disinterested party who has weighed the coal in the office of the consignee, or any other place, is receivable as competent testimony.

The Coal Trade may rely and act upon these views of the case, as the above legal decision is supreme, and final cases of this character having no appeal whatever beyond the court of common pleas—wherein the above was rendered.—*Corr. Pottsville Jour.*

The following is a copy of the record in this case.

New York Common Pleas.—*James Fagan* vs. *Jacob Weeks:* General Term, Oct. 1855.—*Ingraham*, First Judge.

A bill of lading signed by the captain is evidence that the goods therein stated have been received on board of the vessel and cannot be altered by parol evidence: no such evidence was offered in this case, and the plaintiff as assignee of the bill of lading was justified in demanding the quantity of Coal as stated therein.

But I think the justice erred in holding the defendant liable for all the

freight. He was the mere assignee of the bill of lading. As such he was not liable for any freight except of the goods he received.

It is undisputed that all the coal was not delivered, still the Court below has held the defendant liable for the freight of coal not delivered, although it was demanded by him and paid and was not delivered. Even if the original consignee could be made liable under the testimony, which is not admitted, still there can be no doubt that no such liability exists on the part of the assignee who has not received the property. His liability only extends to the property actually received by him, 6 Cow., 504, Abbot on Shipping, 421, Hinsdell *vs.* Weed, 5 Denis, 176. If, at any subsequent period, the master was ready to deliver the residue of the coal, he should have notified the defendant. By so doing he might have avoided liability for the portion of the cargo not delivered.

I am at a loss to see upon what ground the plaintiff can be relieved from the liability he incurred from not delivering the balance.

The bill of lading admitted the receipt of it.—While in process of delivery, he refused to deliver the balance remaining, after the owner had demanded it, alleging that it was not on board, and that he could not deliver what was not there at the time it was demanded; no subsequent offer to deliver was made, and the balance has never been received by the purchaser.

These facts are sufficient to establish at least a *prima facie* case in favor of the defendant.

The defendant, it is to be remembered, is the purchaser of the property from the consignee, and has relied on the bill of lading in making his purchase. He is not bound to accept from the master, property of a different kind from that which the bill of lading describes.

It is said there was a waiver on the part of the defendant when he received a portion of the coal after he was informed it was not all on board.

There could be no waiver in taking all he could get of his property. He had a right to do so, and hold the carrier responsible for the balance.

The judgment must be reversed.

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## COMMERCIAL ASPECT OF THE MINING INTEREST.

New York, March, 1856.

The sales of Mining Stocks are yet very light in private or at either of the boards. The great abundance of money, however, and the certainty of a yet greater abundance, give promise that such Mining Stocks as represent bona fide and actual values will become active and buoyant in no very long period of time. Mining Stocks are the last to rise in an advancing market like the present, and the first to give way in a declining one.

We notice sales at the Mining Stock board of the stocks of the *Gardiner Gold Company*, *Aberdeen Co.*, and *Ward Coal and Iron Co.* The Ward Coal and Iron Co. is a reorganization of the Ward Coal Co. which we have already had occasion to notice. We have not ascertained the precise cause for this change of organization, but suppose there were weighty reasons for it. The President of the company in its new form is George C. Ripley, Esq. The stock was introduced last month at the board at 25 per cent, and has risen to 32. The par value of the company's stock is much higher than that of the

now extinct Ward Company, the stock of which was $5 per share but sold at $1. We learn that the new company have been raising $25,000 on their bonds, with a view to recommence the working of their mines, which has been suspended during the winter months.

Numerous new Coal Companies are being formed for the mining of coal, and the market will be soon astonished by the appearance of new coal stocks. Among those recently introduced is the stock of a Company, called "*The Chirique Improvement Co.*" This is a company formed for the mining of coal in South, or Central America. The company has been incorporated by the Legislature of Pennsylvania with a perpetual charter. The company possess 1,200,000 acres of agricultural and mineral lands in the province of Chirique, in the Republic of New Granada, extending from the Pacific coast to the Atlantic across the continent, and own a harbor and a city site on both sides of the Isthmus. The harbor on the Atlantic side is in the Bay of Boca del Toro, not far from the Chirique lagoon. The harbor on the Pacific side is in the Golfe Dulce. Coal extends across this Isthmus from Ocean to Ocean, which this company have undertaken to mine. For this purpose a company has been organized with a capital of $2,000,000, in shares of $100 each per value, under the following board of Directors:—Messrs. Cornelius Vanderbilt, N. H. Wolfe, Joseph L. White, James S. Sandford, Wm. R. Foster, Ambrose W. Thompson, Joseph Foulke, J. Eugene Flandin, Wm. M. Godwin, and Samuel E. Johnson, who is elected President.

Professor Benjamin Silliman, Junior, has published a pamphlet, called "Fuel for Locomotive Steam Use," recommending coal instead of wood for their locomotives; he says, in England, Belgium, and every where in Europe outside of Russia, coke is almost the only locomotive fuel employed; he adds the important statement, that anthracite coal is the coke of bituminous coal, produced on a gigantic scale by those stupendous operations of nature which heaved up the Alleghanies from their original horizontal position. This great upheaval was accompanied by the escape of highly heated vapor, of water, and other gases, which passing through the coal seams, have carried off their volatile ingredients, leaving them completely debituminized. This disturbing influence reached its maximum in the north-eastern and eastern portion of the anthracite regions, where the hardest anthracites are now found, while to the West and South, as the textures of the strata become more gentle and the troughs more open, there is a corresponding difference in the character of the included coals, which become softer and more combustible.

The hard and more perfect anthracites are found in the eastern and north-eastern margins of the anthracite regions in the Lehigh, Mauch-Chunk and Wilkesbarre districts. Turn now to the western and southerly districts of the great anthracite region, and we observe from the chemical analyses of the coals of that region, a steady increase in the amount of volatile matter as we move in the direction of the more gentle disturbances. The coals become softer, and asume a character intermediate between the hard and moderately hard anthracites, and the semi-bituminous coals. They are in fact, as Prof. H. D. Rogers has happily designated them, "Semi-Anthracites," coal which ignite easily, burn freely, and still are in no sense bituminous coals, not even semi-bituminous coals, but semi-anthracite.

These coals have as yet been almost unknown in our eastern markets, and their peculiar value as steam coals, and particularly for locomotive use, has been but little understood, except by a few persons who have made it a study. Two companies have been formed to work these semi-anthracite coals, "*The Mahanoy and Shamokin Improvement Company*, and *The Zerbe's Run and Shamokin Improvement Company*.

We have already alluded to the *Saline Coal and Manufacturing Co.*, who are about increasing their capital, with a view to extend their manufacture of iron rails. The directors have nearly arranged the $1,200,000 additional capital, making a total of $3,000,000.

Messrs. Woodward & Ellis, two of the directors, have successfully canvassed the western cities, Cincinnati, Indianapolis, Chicago, and St. Louis, and will shortly appear in New York to complete their subscription list. The western railroad interest subscribed liberally. An estimate of the demand for coal in the South-west will be found further in these pages. We understand the Maryland Legislature have granted authority to the Cumberland Coal Co. to reduce its stock and dispose of part of its coal lands. The stock of this company has been very steady all through the month; the readiness with which the friends of the road have been buying its stock whenever offered below present rates, has prevented great fluctuations. The stock of the *Reading Railroad Co.* has been very active under a speculative demand, and its price has gone up to 93 since payment of the dividend.

The annual report of the *Hampshire Coal and Iron Company* states that during 1855 the company sent to market 65,080 tons coal, at an average profit of 48 cents per ton, equal to $7\frac{2}{3}$ per cent. on the cost of the stock, which was $20 per share. These profits were used in paying the debts of the company. There have been issued $62,500 of the $100,000 bonds authorized at a stockholder's meeting. The entire debt of the company is $88,875, including $32,000 advanced by coal dealers, to be repaid during the next six to nine months by deliveries of coal under contracts which pay a profit of about 54 cents per ton. The lands of the company comprise about 10,000 acres in Hampshire and Hardy Counties. The mines of the company are about one mile from Piedmont, and about half a mile from the Baltimore and Ohio Railroad. The equipage, etc., of the company are equal to three times the amount of business now done by this company.

A new Company, as noticed in our December number, has been formed with a charter from the State of Pennsylvania, called *The Pennsylvania Lead Co.*, which is a consolidation of the three whole companies, called respectively *The Wheatley*, *The Brookdale*, and *The Phœnix Lead Mines, Penn.* The company has a capital stock of $500,000, divided into 100,000 shares of $5 each. The stockholders of the old companies will exchange their certificates for certificates of stock in the new Company on payment of an assessment of 8 cents per share; the President of the Company is Dr. J. C. Beales; Treasurer, Joseph Steele; Secretary, Edward With; and Manager, Charles M. Wheatley.

Money is accumulating very fast in the Market of New York, and great difficulty is found in placing it at 6 per cent. The deposits in Bank and with

private bankers on account of Banks and other parties in the interior, are fast accumulating. The domestic exchanges are all in favor of New York, occasioning coin to come here in large quantities. At the same time the semi-monthly receipts from California are large, and the exports of specie to Europe disproportionately small. On the first of June next Mr. Guthrie, the Secretary of the Treasury, has given notice that he will pay the $7,750,000 to the holders of Texas State claims who shall have complied with the provisions of the act of Congress. The great proportion of these claims are held and owned in Wall street, and what will be the effect of the then great abundance of money in market we will not venture to say. Our indebtedness to Europe on private account is unusually little. Foreign bankers here have larger balances than usual on the other side. Our imports last year were light and are mostly paid for. The demand for foreign exchange is not comparatively heavy, while the exports of cotton are on the increase, furnishing a steady supply of exchange on Europe without much need of gold to balance the trade transactions between the two continents.

Were it not for the disturbances springing from the state of our relations with Great Britain, a surplus of money would run freely into speculation of all kinds. Those disturbances can only be temporary, and when removed, we may expect to see a brisk business in every department of trade. Speculation has already commenced in real estate and must increase, stock values will follow soon after as holders of money get tired of submitting to lower and lower rates of interest.

The *Franklinite Company* of New Jersey is taking active measures for working its valuable mines of zinc and iron ore, situated in Franklin, Sussex County, New Jersey. The company has a valuable mineral estate, yielding excellent iron, and rivalling in quality that in Sweden and Russia. The English have a monopoly of the steel manufacture from their supplies of Swedish iron, only a limited amount of which is allowed to be exported from Sweden. The steel made out of the iron of the Franklinite ore, is of a finer grain and polish than that made out of the English iron. None but that made from Swedish iron is equal to the company's; and that would be excluded by its greater cost, when the Franklinite works are made to yield to their full extent. The company are now raising money to complete their works with one blast furnace.

*Fluctuations in Mining Stocks at Boston during 1855, by J. G. Martin.*

| Copper Mining Companies. | Paid in. | 1855. Highest. | 1855. Lowest. | Shares sold in 1855. | January 2d. 1856. | February 1st. | March 1st. | April 2d. | May 1st. | June 1st. | July 2d. | August 1st. | Sept. 2d. | October 1st. | November 1st. | December 1st. | January 2d. 1856. | Dividends. 1855. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper Falls | $17 00 | 45 | ‡44 | 4,191 | ‡34 | 45 | 39 | 41‡ | ‡43 | 35 | 33‡ | 28 | 18 | 14‡ | ‡16 | ‡5 | ‡7‡ | 0 |
| Forest Copper | 13 00 | 8 | 1 | 1,037 | 5 | 7 | 8‡ | 7 | ‡34 | ‡4 | 5‡ | 3 | ‡31 | 34 | 3 | 2 | 1 | 0 |
| Isle Royale | 14 00 | 171 | 74 | 11,527 | 8 | ‡11 | 9 | 8 | 8* | 8 | ‡14 | 13‡ | 14 | 17‡ | 12 | 13‡ | 12‡ | 0 |
| Minnesota | 3 30 | $46‡ | 38 | 950 | 140 | 140 | 150 | 197 | 185* | 200 | ‡30 | 37‡ | 40‡ | 46‡ | 45 | 42 | 42 | $15 |
| Phœnix | 8 50 | 5 | | 638 | | | | | | | | | | | | | | |
| Rockland | 2 00 | 15‡ | 2 | 1,810 | 2‡ | 4‡ | 5‡ | 2‡ | ‡43 | ‡38 | 51 | 37‡ | 40‡ | 44 | 15 | 4 | 3 | 0 |
| Pittsburg, (Cliff) | 18 50 | 181 | 9 | 169 | 9 | 9 | 9 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 13‡ | 0 |
| Toltec | 11 00 | 12‡ | 3 | 32,100 | 3‡ | ‡8‡ | 6‡ | 9‡ | 8‡ | 9‡ | 11‡ | 12 | 11 | 9‡ | 8 | 5‡ | 6 | $8 |

* Ex Dividend, which applies to all the tables. † Assessment paid. ‡ Shares doubled. § Every 3 shares made 20.

# COALS AND COLLIERIES.

### ANTHRACITE COAL TRADE for 1856.

| | | |
|---|---|---|
| Shipments by Reading Railroad to Feb. 28th, . . . | 256,398 02 | tons |
| Same time last year, . . . . . | 294,490 05 | " |
| Decrease, . . . . . | 38,082 03 | " |

### CUMBERLAND COAL TRADE.

| | | |
|---|---|---|
| Shipments to Feb. 23d, . . . . . | 22,293 19 | tons |

### PROGRESS OF THE COAL TRADE,
By P. W. Sheafer, Pottsville, Pa.

| | *Population.* | *Anthracite Coal Trade.* | *Inhabitants per ton Consumed.* |
|---|---|---|---|
| 1820, . | 12,866,020 . . . | 174,784 . . | 73·6 |
| 1840, . | 17,069,453 . . . | 865,414 . . | 19·7 |
| 1850, . | 23,191,876 . . . | 3,356,899 . . | 6·9 |
| 1860, . | *31,510,802 . . . | 10,000,000 . | 3.17 |

Comparison of the yield of North and South dipping coal strata, as shown by the produce of 105 collieries, in Schuylkill County, in 1854.

| | |
|---|---|
| Red Ash coal from 58 collieries { 10 North dips . . . . | 84,732 |
| { 48 South " . . . . | 570,561 |
| Red Ash coal from 11 collieries, North and South dips . . . | 305,022 |
| White Ash coal from 5 collieries, North dips . . . . | 91,233 |
| " " 26 " South " . . . . | 745,231 |
| " " 5 " North and South dips . . | 120,101 |
| Total White and Red Ash, from 105 collieries . . . | 1,916,870 |

*Recapitulation.*

| | |
|---|---|
| Total mined on North dips . . | 175,955 |
| " " North and South dips . | 425,123 |
| " " South dips . . | 1,315,792 |
| Total . . . . . | 1,916,870 |

The geological explanation of this great disparity is briefly this,—the North dipping strata are more steeply inclined, and more broken in consequence, as is supposed, of the manner in which the forces of upheaval acted upon the respective beds.

### REPORT TO THE COAL ASSOCIATION OF SCHUYLKILL COUNTY.

Gentlemen:—The object which has called us together on this occasion is twofold. First, to render an account of the doings of the Board of Trade, during the past year; and second, to consider the probable interests of the Trade in the future.

The organization of the Board under its present Constitution, is but of recent date. Scarcely eight months have elapsed since the election of its members to their present responsible position, and of necessity, its transactions have been few and cautious.

It was not anticipated when the Board was first organized, that much could be accomplished within the first year. It was deemed sufficient to give form and life to the Association, and to look to the future for the fruits of ef-

* As estimated by De Bow.

ficient operation. The principles of confidence and self-protection will mature and strengthen as occasion requires, or as experience may dictate.

It is believed that a change has taken place in the views and feelings of the operators of this county, and that the Coal Business can now be brought within the control of safe and rational principles.

A lesson has been taught us last year, which may prove a lasting benefit at home and abroad.

The greater interest, however, to which our attention is now called, lies in the future. The opening of another season of active employment, of toil and labor, and privation, is near at hand. And we have come here to-day, to counsel and deliberate whether that season of labor shall be one of remuneration to the operators for their investments and energies, and by what means it may best be accomplished. That it can be made so admits of no doubt. But by what means it is most readily effected may be a matter of opinion between different minds.

On this subject especially it is desirable that every operator should express himself freely, and after a full expression of the various opinions, sum them up, compare notes, and deduct the conclusion.

To give unity to the Coal Trade of this county, is of the utmost importance. Every one engaged in the mining of Coal now deems it as absolutely necessary that a business of such magnitude as that which the Board of Trade represents, involving interests so immense, both to the operators and the public, should no longer be carried on as heretofore, wildly and recklessly, without any regard either to producer or consumer.

A self-relying and self-protecting principle must be established, or the business will continue to be fluctuating, unsafe and unprofitable.

In England and elsewhere, the Iron, Coal, Grain, and other leading interests, are controlled by Boards of Trade upon the established principle of supply and demand.

In this country, the Iron, Cotton, Grain, and other leading commodities are represented by their respective Boards of Trade, in every commercial city of the Union, and controlled upon the same principle. Coal alone has thus far been left unprotected by the unerring guide of political economy, and just so long as this shall continue, so long must we anticipate an unstable and unprofitable business.

Nothing seems easier, or more important, than to bring the Coal business of this county completely under the control and influence of the same principle. When no Coal is wanted, none need be, and none should be mined. Coal costs nothing under ground.

Forcing Coal into market when it is not wanted, is admitted by all to be unreasonable, and the consequences are always ruinous.

While I would counsel strict adherence to this principle, I would recommend that every effort be made to furnish a supply to the market when it is required. The supply should be so regulated by the demand, that the consumers could have the cheapest possible fuel, and the operators remunerative prices.

With the Board of Trade of Schuylkill county fully empowered to regulate the supply by the demand, these objects could in a great measure be accomplished. But it will require the co-operation of the other Anthracite Coal Fields to accomplish them most fully. The efforts of the Board will be continued to establish this union of action between the different districts, and the correctness of the principle leads me to hope that it will be ultimately accomplished.

There are other advantages derived from the Association. It constitutes a proper guard against injurious legislation, and against any designs and measures, whenever they may arise, tending to embarrass or hurt the trade. Also, improved systems for ventilating, and mechanical appliances, tending to further security of the operatives, and reducing the cost of production; and such other improvements as the collective experience of the Association in the

frequent and social intercourse with each other (for which the Association Rooms will furnish ample opportunity), may suggest.

In conclusion, I congratulate the Association upon its present flattering prospects of usefulness to its members and the public. May wisdom guide your deliberations, and an earnest adherence thereto will crown your efforts with a compensating Trade.

S. SILLIMAN, *President.*

*Pottsville, February 8th*, 1856.

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THE EMPIRE COAL COMPANY.

This Company owns mines adjoining the Borough of Wilkesbarre, Penn., having a front on the North Branch canal of 1150 feet; John Ely is the President. Their property consists of 616 acres of land. Prof. Rodgers says, "Exact measurement has already disclosed, in the vicinity of Wilkesbarre, the widest and apparently the deepest portion of the coal field, the existence of from 1000 to 1,200 or more feet of coal-bearing strata, and the presence within these of sixteen or eighteen separate beds of coal, two of them being compound seams of great size." We take the following extract from the report of this Company.

*The Revenue of Coal Estates.*—The only sure way to estimate the profits that the Empire Coal Company may make in the mining and selling of coal, is the success of similar companies now in operation in the Wyoming region. The chief of those are the Baltimore and the Pennsylvania Coal Companies, and the Delaware and Hudson Coal Company, though it must be remembered that the outlet of the first named has been confined to the southern market, before shown to be by far the least eligible of those now opened, and that the profits of the others have been diminished by the expenses of, and interest on their long lines of improvements. Yet the Baltimore Coal Company has cleared annually, $60,000 upon an investment in lands and machinery of only $130,000, and its stock is at over 100 per cent. premium.

The Pennsylvania Coal Company, laboring under the disadvantages of route before alluded to, reports a net profit last year of $353,826 44, being 11½ per cent. on its capital stock, and leaving a reserved fund of $138,984 63. The profits and dividends of the Delaware and Hudson Canal Company also are about the same, and the premiums which the stock of each have commanded through the financial difficulties which have prostratsd so many other enterprises, are well known. If, however, their coal business proper was kept separate from the items of railway and canal construction and repair, it would appear even more remunerative. This is evidenced by the Delaware, Lackawanna and Western Rail Road Company in the same region, the coal department of which, in 1854, as shown by their last report, cleared $140,000 on a sale of 134,000 tons.

The profits divided among the stockholders of the Delaware and Hudson Canal and Coal Company for ten consecutive years, with the percentage on the capital (which varied) at the time of making the dividend, have been as follows:

| | | | |
|---|---|---|---|
| 1843 | 8 | per cent., | $158,760 |
| 1844 | 8 | " | 158,760 |
| 1845 | 9 | " | 211,420 |
| 1846 | 16 | " | 445,904 |
| 1847 | 20 | " | 576,600 |
| 1848 | 18 | " | 661,162 |
| 1849 | 16 | " | 730,860 |
| 1850 | 14 | " | 509,248 |
| 1851 | | | 459,281 |
| 1852 | | | 764,908 |
| | | | $4,966,403 |

And in eight of those ten years there was a surplus of profits kept as a reserved fund of nearly a million and three-quarters, namely:

| | |
|---|---|
| 1843 | $534,836 |
| 1844 | 548,182 |
| 1845 | 58,706 |
| 1846 | 87,209 |
| 1847 | 252,280 |
| 1848 | 118,460 |
| 1849 | 122,281 |
| 1850 | 68,954 |
| | $1,741,058 |

When the Delaware and Hudson Canal Company commenced operation, they were obliged to open a way to tide-water at great expense, and they had to wait for a market to grow up, the country being unaccustomed to the use of mineral coal, and the population much less than at present.

### MARYLAND COLLIERIES.

The present productive capacity of the collieries located in different sections of the region, amounts to at least 1,200,000 tons per annum, which, if facilities were at hand to transport it to market, where it could be disposed of at, say three dollars and fifty cents per ton, would amount to four million two hundred thousand dollars. The additional fixtures and appliances necessary to double the amount would cost but a small sum. But there is a great obstacle in the way of a large increase of the coal business. The lack of facilities to transport it to market is seriously felt, and it will require time, energy, and capital to build them up.

### COMPARATIVE STATEMENT OF CUMBERLAND COAL TRADE FOR 1854-55.

| | 1854. | | | 1855. | | |
|---|---|---|---|---|---|---|
| | FORWARDED BY | | | FORWARDED BY | | |
| | Rail Road. | Canal. | Total. | Rail Road. | Canal. | Total. |
| FROSTBURG. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| Cumberland Coal & Iron Co., | 173,580 | 92,141 | 265,721 | 97,699 | 100,691 | 198,390 |
| Frostburg Coal Co., | 50,957 | 24,814 | 75,271 | 27,868 | 16,209 | 43,572 |
| Borden Mining Co., | 52,319 | 23,625 | 75,944 | 41,717 | 31,399 | 73,116 |
| Allegany Mining Co., | 44,989 | 15,792 | 60,781 | 20,172 | 29,487 | 49,659 |
| Parker Vein Coal Co., | 688 | | 688 | | | |
| Carbon Hill Coal Co., | | | | 2,573 | | 2,573 |
| Union Coal & Iron Co., | | | | 2,097 | | 2,097 |
| PIEDMONT. | | | | | | |
| Hampshire Coal & Iron Co., | | | | 64,051 | | 64,051 |
| New Creek Coal Co., | 22,708 | | 22,708 | 8,217 | | 8,217 |
| George's Creek Coal & I. Co., | 57,321 | | 57,321 | 39,008 | | 39,008 |
| Swanton Coal & Iron Co., | 47,920 | | 47,920 | 57,197 | 6,084 | 63,281 |
| American Coal Co., | 87,709 | | 87,709 | 97,078 | | 97,078 |
| Phœnix Coal Co., | 7,490 | | 7,490 | | | |
| Llangollen Coal Co., | 8,155 | | 8,155 | 8,800 | | 8,800 |
| Lonaconing Coal & I. Co., | | | | | 602 | 602 |
| Franklin Coal Co., | | | | 15,174 | | 15,174 |
| FAIRMOUNT. | | | | | | |
| Palatine Gas Coal Co., | 62,163 | | 62,163 | 34,783 | 435 | 35,268 |
| Orrel Coal Co., | | | | 4,698 | | 4,698 |
| | 565,999 | 155,872 | 721,871 | 510,622 | 184,907 | 695,529 |

*Statement showing the Quantity of Coal forwarded from the Frostb*

| 1855 | FROSTBURG REGION. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C. C. & I. C. | | | Frostburg Coal Co. | | | Borden Mining Co. | | | Allegany Mining Co. | | | Carbon Hill C C. | Un C. & |
| Month | R. R. | Canal | Total | R. R. | Canal | Total | R. R. | Canal | Total | R. R. | Canal | Total | R. R. | R. |
| Jan. | 8,581 | | 8,581 | 1,510 | | 1,510 | 513 | | 513 | 172 | | 172 | | |
| Feb. | 3,606 | 461 | 4,067 | 1,010 | | 1,010 | 1,031 | | 1,031 | 1,022 | | 1,022 | 404 | |
| March | 3,921 | 2,537 | 6,458 | 1,891 | 1,845 | 3,736 | 3,485 | 674 | 4,109 | 1,240 | 1,820 | 3,060 | 676 | |
| April | 5,989 | 10,815 | 16,804 | 2,373 | 1,743 | 4,116 | 4,411 | 3,018 | 7,429 | 2,212 | 5,841 | 7,753 | 723 | |
| May | 7,647 | 16,002 | 23,649 | 2,192 | 663 | 2,855 | 3,666 | 5,397 | 9,063 | 3,044 | 4,270 | 7,314 | 662 | |
| June | 7,400 | 15,725 | 23,125 | 3,380 | 1,736 | 5,116 | 2,944 | 4,760 | 7,704 | 3,017 | 3,603 | 6,620 | 74 | |
| July | 8,979 | 13,097 | 22,076 | 4,497 | 1,753 | 6,250 | 2,837 | 3,860 | 6,697 | 1,322 | 2,741 | 4,063 | 34 | |
| Aug. | 8,749 | 4,384 | 13,134 | 3,951 | 506 | 4,457 | 5,352 | 1,115 | 6,467 | 2,192 | 406 | 2,598 | | |
| Sept. | 12,800 | 5,737 | 18,037 | 1,377 | 2,603 | 3,980 | 6,657 | 3,961 | 10,618 | 1,325 | 3,318 | 4,643 | | |
| Oct. | 11,110 | 13,159 | 24,269 | 1,992 | 2,974 | 4,966 | 3,879 | 3,900 | 7,779 | 1,794 | 4,128 | 5,922 | | |
| Nov. | 11,892 | 13,511 | 25,403 | 1,377 | 23,71 | 3,748 | 4,084 | 3,849 | 7,933 | 1,632 | 3,128 | 4,760 | | |
| Dec. | 7,525 | 5,263 | 12,788 | 1,813 | 15 | 1,828 | 2,908 | 865 | 3,773 | 1,200 | 532 | 1,732 | | |
| Totals | 97,699 | 100,691 | 198,390 | 27,363 | 16,209 | 43,572 | 41,717 | 31,399 | 73,116 | 20,172 | 29,487 | 49,659 | 2,573 | 2, |

* Derived from official sources through R. G. Rankin.

RECAPITULATION.

| | | | | |
|---|---|---|---|---|
| FROSTBURG REGION, | by Rail Road | 191,621 | | |
| " " | by Canal | 177,786 | | |
| | | | 369,407 | |
| PIEDMONT " | by Rail Road | 279,520 | | |
| " " | by Canal | 6,636 | | |
| | | | 286,156 | |
| FAIRMOUNT " | by Rail Road | 39,481 | | |
| " " | by Canal | 485 | | |
| | | | 39,966 | |
| | *Aggregate,* | | 695,529 | tons. |

PICKELL COAL COMPANY.

The property of the company, says the report, is composed of 700 acres of land. and contains three workable veins of coal, of fifteen, four, and six feet respectively. Taking an average area of these veins, it wil give 400 acres of the aggregate thickness of twenty-five feet of coal.

The improvements now in progress of construction, embrace a sufficient area for a coke yard adjoining the load house. The fine or dust Coal is converted by a cheap mode of burning in open pits, into a very superior quality of coke, which readily commands from $3.25 to $3.50 per ton. The small quantity of earthy matter in the Coal, the absence of pyrites, and the extraordinary property it possesses of agglutination, renders the fine or dust coal, the most suitable for this purpose, and which otherwise would in a great measure be wasted.—*Cumber. Jour.*

ANTHRACITE IN VIRGINIA.

We learn from the best authority, that pure anthracite coal, in large quantity, has recently been found on the waters of Patterson Creek, near its mouth, in the county of Botetort. The discovery is of great importance, as the forges and foundries in that region have heretofore, to some extent, been operated with stone coal, carried up from this city, a distance of two hundred miles. This anthracite coal, being very near the James River and Kanawha Canal, must throw upon it a large amount of tonnage—thereby conferring a vast benefit upon several of the great interests of the State.—*Richmond Examiner.*

*Piedmont and Fairmount Regions during each Month of* 1855.*

| PIEDMONT REGION. | | | | | | | | | | FAIRMOUNT REGION. | | Aggregate. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pshire L. Co. | New Creek | Llangollen Coal Co. | George's Creek | American C. Co. | Swanton C. & I. C. | | | Lonaconing C. & I. C. | Franklin C. Co. | Palatine Gas C.C. | Orrel C. C. | |
| . R. | R. R. | R. R. | R. R. | R. R. | R. R. | Canal | Total | Canal | R. R. | R. R. | R. R. | Tons. |
| 2,386 | 30 | For the Year (*about*) | 2,552 | 4,533 | 5,745 | | 5,745 | For the Year. | | 2,570 | | 93,592 |
| 1,414 | | | 2,283 | 1,924 | 4,707 | | 4,707 | | | 1,419 | | 19,281 |
| 4,312 | 73 | | 2,429 | 4,795 | 7,219 | | 7,219 | | | 3,912 | | 40,789 |
| 4,628 | 724 | | 3,033 | 6,924 | 7,560 | | 7,560 | | | 3,587 | | 63,281 |
| 4,897 | 959 | | 4,015 | 12,470 | 6,554 | | 6,554 | | | 6,866 | | 78,804 |
| 8,690 | 562 | | 3,135 | 15,007 | 5,624 | | 5,624 | | | 6,316 | 120 | 82,093 |
| 5,293 | 537 | | 2,623 | 10,273 | 6,360 | | 6,360 | | 2,524 | 692 | | 67,597 |
| 7,348 | 196 | | 3,181 | 12,346 | 3,221 | 2,000 | 5,221 | | 3,406 | 2,056 | 102 | 61,445 |
| 6,010 | | | 3,237 | 11,460 | 3,897 | 1,000 | 4,897 | | 3,260 | 1,612 | 281 | 69,032 |
| 5,982 | 10 | | 4,591 | 7,004 | 2,845 | | 2,845 | | 2,777 | 1,795 | 1,179 | 69,210 |
| 7,616 | 84 | | 3,923 | 5,679 | 2,845 | 2,000 | 4,845 | | 2,406 | 2,742 | 1,501 | 70,170 |
| 5,475 | 42 | 3,800 | 3,976 | 4,655 | 1,120 | 1,034 | 2,154 | 602 | 801 | 2,201 | 1,415 | 45,242 |
| 64,051 | 3,217 | 3,800 | 39,008 | 97,073 | 57,197 | 6,034 | 63,231 | 602 | 15,174 | †35,268 | 4,699 | 695,529 |

† 485 tons of this by Canal.

### COAL ON THE ASHTABULA & NEW LISBON RAILROAD, OHIO.

A correspondent of the Pittsburg *Gazette*, of January 18th, in calling public attention to this road, remarks:

"It is a fact, known to those who have examined this region, that from Niles, on the Mahoning river, in Trumbull county, crossing Mahoning county, to New Lisbon, in Columbiana county (thirty miles), this road will pass over continuous and almost solid beds of bituminous coal, block coal, cannel coal, iron ore of several varieties (including the black band ore), limestone of several varieties, fire clay, and other valuable minerals. The cannel coal alluded to is of the finest quality known. It has been compared with the celebrated Breckenridge coal of Kentucky, and pronounced by competent judges far superior to it, both in fineness of grain and richness of oils. The block coal is of the same quality as the "Briar Hill," running in veins from 4 feet 8 inches to 5 feet 4 inches in thickness, and is the kind now used, in its raw state, by the furnaces along the Mahoning, for manufacturing pig metal. The black band vein of coal (as it is called) is of the the same quality as the Pittsburg coal. This is three and a half feet in thickness, and the vein of black band iron ore lies immediately beneath it, from ten to fourteen inches thick, and is mined along with the coal. The cannel coal is from five to seven feet thick, and undermines many hundred acres, as far as examined, and, from indications, probably thousands of acres. On some of the lands, along the route of this road, are found two workable veins of coal, black band iron ore, a vein of twenty-four inches of very fine blue ore, a vein of kidney and shell ore, limestone and fire clay, all on the same track.

At Ashtabula our road connects with the Lake Shore road, and with Lake Erie, at one of the best harbors, which gives us the whole country bordering on the lakes for a market for the coals. Even Canada has to look to Ohio for her fuel. Western New York will also furnish a large market. The Ashtabula and New Lisbon Railroad passes over the largest mineral region in the State, and these minerals will furnish freight to the road for centuries to come. The Lake Superior iron ores can never be worked at home with profit. They must be taken to the fuel. Trumbull, Mahoning and Columbiana counties will furnish the fuel, and are most convenient for that purpose. Those ores, as well as the Lake Champlain ores, are most profitably worked with our domestic ores, and those ores will furnish back freight for the road. Here the furnaces will be built, and this region is destined to become one of the most important iron manufacturing regions in the United States.

### LA SALLE COAL FIELDS, ILLINOIS.

The coals of La Salle, and its vicinity, are now beginning to attract public attention. Until recently they have hardly been known abroad, and their importance scarcely appreciated at home. With the exception of two shafts already sunk (one that of Messrs. Adams & Carleton, and the other that of Mr. Eggleston), and others being sunk, no attempt at scientific mining has been made. The coal heretofore obtained has been entirely from the outcrop in the bluffs of the Little Vermilion and Swanson Ravine, where it has been more or less exposed to the action of the elements, and is therefore of an inferior quality compared to that which is obtained from the shafts. The La Salle *coal basin* underlies the Illinois River and the cities of La Salle and Peru, and crops out along the bluffs of the Big and Little Vermilion Rivers, which empty into the Illinois near this place.

It has three principal beds; the first being from four to five feet thick, the second about six, and the third from thirty inches to four feet. They lie in the order named, the first being nearest the surface, though they all *crop out* on the bluffs of the Big and Little Vermilion Rivers. The depths at which they lie in other places depend upon the *dip* of the strata. Messrs. Adams & Co., at their shaft south of the Illinois River, about a mile above this city, have struck the third bed at a depth of less than one hundred feet. Mr. Eggleston, at his shaft, about eighty feet in depth, near the Canal, on the north side of the river, is raising coal from the middle bed. He is now working a six feet vein, the upper part of which is cannel coal, somewhat earthy, but of a pretty good quality. *The La Salle Coal Mining Company*, (generally known as the *Kentucky Company*,) on the Little Vermilion, expect to strike the first bed at the depth of 190 feet, the second at 243, and the third at 335 feet. Their shaft, which is now sunk to the depth of 125 feet, has already penetrated several irregular seams of coal, but not of sufficient thickness to pay for working. The upper workable seam is considered rather inferior in quality to the second and third; but at the depth at which this company will strike it, it will no doubt prove superior to the coal obtained from the outcrops. Its quality has been tested; but this company, as well as all others who have commenced or are about to commence sinking shafts, rely upon the middle and lower beds for the *best* coal, which will compare with any bituminous coal now in this State.

The *supply* of coal to be obtained from the La Salle coal basin is almost exhaustless, if not incalculable; and the *product* will annually increase for generations to come. That a market will always be found for its whole yield, no matter what the amount, is certain. It is known that this is the northern limit of the coal field in this State, and this fact alone would render our coal basin more valuable than many others in the western States.

Below we give a statement of the amount of coal forwarded by the Central Railroad during the month of December:

| Fordwarded by | No. of Tons. |
|---|---|
| Field & Rounds, | 960 |
| L. Eggleston, | 360 |
| A. J. Hartshorn, | 220 |
| R. Elliott & Co., | 140 |
| V. O. Hatch, | 120 |
| Kentucky Co., | 90 |
| Mansell & Co., | 40 |
| A. Main, | 10 |
| Total, | 1,730 |
| No. of tons forwarded in November, | 1,330 |
| " " October, | 560 |

Of the amount forwarded in December, 330 tons were sent to Rockford, 220 to Dixon, 140 to Mendota, 100 to Freeport, and the balance mostly to other towns on the Central Road north. This does not include our home consumption.—*La Salle Press.*

### DISTILLATION OF COAL SHALES.

This subject is of great importance, especially to parties owning soft coal fields at a distance from great avenues to market. Soft coal, rich in volatile matter, is suitable for this purpose.

In a report on the lands of the Monroe Company in McKean County, Penn., Mr. P. W. Sheafer thus speaks of the importance of distillation of coal.

The distillation of Cannel Coal, and some kinds of bituminous coals, for the sake of the illuminating oils thus obtained, is a process lately risen to great importance, and bids fair to become one of the most prominent uses to which this class of mineral fuel will be applied. A company has lately been organized in western Pennsylvania for the manufacture of oil from Cannel Coal, and the profit is found to exceed, by far, that which can be realized for the sale of the coal for gas-making and other purposes. The experience of this company has established a point of great importance, viz., that some of the shales accompanying cannel coal veins, although unfit for fuel, contain as much oil as coal itself.

With regard to the distillation of bituminous shales, it has been done for some years in Europe. Seligue obtained various kinds of oil and paraffine from the bituminous shale of Autun; and similar products were, for a time, extracted from the shale of Dartmoor, in the west of England. Latterly, Wiseman & Co. are successfully working Seligue's process at Buel, near Bonn on the Rhine. The factory at Buel produces paraffine, which at two shillings sterling per pound is capable of competing with wax and spermacetti in England, and a volatile oil of sp. gr. 0.730, adapted for cleaning clothes, gloves, and used also as a solvent for resins, and for mixing with other less volatile products, to form good burning oil of sp. gr. 0.830 for camphene. This oil is sold at something less than four shillings (English) per gallon. Fixed oils are likewise obtained, which can be rendered drying, and used as paint, or burnt for the production of lampblack. Asphalt and coarse cart grease are also manufactured from the products of the distillation.

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### BRECKENRIDGE COAL.

Addington D. Frye, one of the Managers of the recent Twenty-ninth Annual Fair of the American Institute, called upon the Corresponding Secretary and Agent, Mr. Leonard, for a Report on this subject, made by Mr. John Thompson, Treasurer of the Breckenridge Cannel Coal Company, to the American Institute. The Report gives the appointment by the Government of Kentucky of Commisioners to examine and report, and a Charter of the Company by that State, of Feb. 9th, 1854, and a Report of Benjamin Silliman, jr., George D. Prentice, and Bryan R. Young, the Commissioners. By full examination of the quantity of this very peculiar Coal, it appears to lie under at least four thousand acres of land of the Company, and to be of about (the measure) three feet thickness for the whole territory, with a bituminous shale lying under it. The Coal is covered by a well-disposed cover of sandstone, forming a solid, level roof. This Coal resembles jet; does not soil any thing; can be made into ornaments; contains only eight per cent. ashes, and contains the following proportions of matter: volatile matter (gas) 63.52; carbon, in coke, 27.16; water 7.77. It is improperly called Cannel Coal. It burns as readily as pine wood, and burns long. It is known to be capable of yielding benzole (gas). a resinous matter, in the proportion of twenty gallons per ton. This benzole dissolves India-rubber and gutta percha. The benzole evaporates and leaves the rubber perfect. Each ton of this contains, in addition to the be. zole, 28 gallons of illuminating oil, or kerocene (waxy matter), which burns as brightly as camphene, but has no explosive property whatever. It also contains thirty-five gallons of lubricating oil (paraffine), a fatty matter. Also twenty-five pounds weight of paraffine wax, equal to the best candle wax. The coke left from the distillation of the Coal is sufficient to

supply fuel to the whole of the manufactory, so that all these substances may be extracted without requiring the aid of any foreign substance for fuel. Altogether this is looked upon by the members of the Club as the most remarkable natural substance ever discovered in the earth. The subject leads all reflecting minds to think that it is not improbable that other and still more important discoveries may be made in this wonderfully progressive age, in the development of science and discovery of the buried riches of the earth.—*American Institute.*

– Messrs. William & John Cairnes, of Cloverport, Ky., near the Breckenridge mines, have erected works, and are just commencing operations on a scale to give 2,000 gallons per day. Their works are so built as to be easily and cheaply enlarged to 5,000 gallons per day.

In April, the public will have the pleasure of testing and deciding on the merits of Breckenridge coal oils. One thing is certain, a most thorough effort, braced up by the fullest confidence of success, is being made to give the world a substitute for the whale.

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WYOMING COAL TRADE.

It has been suggested that some of the statistics of the Wyoming coal trade in the last number of the Magazine are overrated. Some companies who are reported as shipping coal, it is said, have never struck coal at all, nor shipped one ton of their own mining. The article was misplaced in the page, and should have been arranged with the other statistics, for which we were indebted to the Pottsville Journal. Before the coal almanac is published by that journal they should examine into these figures.

IMPROVED FORM OF COKE OVEN.

Attention has been directed to the improved form of coke ovens which Mr. Devy, of the old Jewry, has recently patented, by means of which this saving has been proved to have been accomplished. In Mr. Devy's form of coke oven the volatile combustible matter of the coal is economized, and is not entirely lost; on the contrary, it is employed as the means of converting coal into coke, and that by the excessive heat which it evolves in burning. The longer and higher the heat to which carbon from coal is exposed, the more it contracts, and, consequently, the more dense the coke becomes. This high degree of heat is attained under Mr. Devy's invention by means of an arrangement of flues, which pass beneath the bed or hearth of the coke oven, and round its sides, the whole being formed of fire-brick including the inner chamber. The chamber is hereby converted into an extensive retort, in which the carbonizing process is conducted. The next consideration in respect of the manufacture of coke is time. The coke hereby made appears to possess equal, if not greater, density and brightness, as the best samples of coke of ordinary production, whether taking into consideration its fine, bright, and silvery hue, or its granulous and compact texture. At any rate, if uniformly the extreme results may not exactly be obtained by Mr. Devy's process, and allowing even a margin for the difference which always exists between bare theory and practical result, when the public attention becomes directed to those improvements which now are being made in the form, disposition and construction of the modern coke oven, a very considerable saving will, by its application, be effected in the raw material employed. Economy in time, with an increased production, will be realized, by which a proportionate saving must accrue, which, whether in relation to its operation on the integral railway system, or in the productions of the blast or smelting furnace, foundries, or coke-works, at the year's end, in proportion to the saving attained, a balance will appear on the profit side of the account, such as heretofore has not arisen in the uses and adaption of coke, whether as an article of commerce, the means of manufacture, or in its application to refining, malting, or any other domestic purposes.—*London Journal.*

COAL IN LOCOMOTIVES.

By the report of G. A. Nichols, Esq., Superintendent of traffic on the Philadelphia and Reading Railroad, it appears that every ton of Coal sent to market in 1855 over this road, was transported with locomotives using Anthracite Coal as fuel, and at a cost, less per ton, than ever before attained. The cost of transporting Coal in 1855 was 4.92-100 cents per ton less than in 1854.

The actual cost of trasporting a ton of Coal to Richmond during 1855, for the round trip of 190 miles down and up, was 33.61 cents per ton—including maintenance of road, 54-38 cents per ton. Merchandise per ton 80.01 cents—including maintenance of road 108 cents—Passengers each 84.49 cents—including maintenance of road 125.54 cts We doubt whether there is a railroad in this country, or in the world, which can give such an exhibit of cheapness of transportation.

A new locomotive engine, adapted to the use of bituminous coal, has just been placed on the Boston and Maine Railroad. It is a large, first-class freight machine, built expressly for the purpose at the Manchester (N. H.) Locomotive Works, under the direction of the efficient Superintendent, O. W. Bailey, Esq., the patentee. The following are its dimensions: Weight 25 tons; length of the barrel of boiler, 11 feet; diameter of the same, 42 inches; number of tubes 122, each 11 feet in length; outside of fire-box shell, 64 by 48 inches area of grate, 15 square feet. The general appearance of the machine is very similar to those adapted for the use of wood, and it probably could be easily altered for that purpose. The fire-box has an opening near the lower part on each side, by which it is easily cleansed of cinders. There are two levers just above the furnace door, by which dampers are moved. The engine came down from Manchester in the early part of last week. About two tons of coal were placed on the tender, and not quite a ton and a half of it was used. The distance is 52 miles, and a common engine would have consumed, say three cords of wood. At the present Boston prices, the expense of fuel would amount to $7.50 for the coal engine, against $24 for the wood—calling soft coal $5 per ton, and wood $7 per cord.

Here we have a saving of nearly two for one, or at Manchester prices (coal $7 and wood $4), the cost of fuel in this engine was $10.50 against $12. Mr. Bailey says he will guarantee a net saving in full of at least twenty-five per cent. In the course of a few years, as wood in New England grows scarcer, this per centage must inevitably be greatly increased. It was found that the machine evaporated eight pounds and a half of water for every pound of coal. We could perceive neither smoke nor cinders emerging from the smoke stack—nothing but the escape steam; and Mr. B. informed us that thus far there has been none, the flues being so constructed (or intended to be) as to consume all the smoke as well as the gases. One great obstacle to the successful use of coal in locomotives has heretofore been the corrosive action of the gases on the iron and machinery, which it is expected that this invention will obviate. If successful, it will give our New-England forests a chance to recuperate, and be joyfully hailed by the lovers of a good wood fire. Thus far, as we learn from Mr. Paul, the Superintendent of the Boston and Maine Railroad machine shop, this new engine has proved highly satisfactory.

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DEMAND AND SUPPLY OF COAL IN THE WEST AND SOUTH-WEST.

The following estimates of the consumption of coal are furnished by E. Webb, Louisville, Kentucky.

Estimate of the consumption of 956 sugar houses, yielding by average each, 312 hogsheads, as per Champoneer's estimate of sugar crop of 1854:

| | |
|---|---|
| Say 956 sugar houses, each 312 hogsheads, making 298,272 hogsheads. Average consumption of wood to each hogshead, 3½ cords, making 1,043,952 cords, at $4 per cord | $4,174,808 |
| Thirteen bushels of coal being equal to 1 cord of wood, 13,571,376 bushels required, and at 25 cents per bushel costs | 3,392,844 |
| | $7,567,652 |

Showing a net saving in favor of coal on 298,272 hogsheads of sugar, of $781,964, over $2 62 per hogshead.

An estimate of the consumption of coal, if entirely used by steamers running between the following points on the Ohio, Mississippi, Cumberland and Tennessee Rivers.

| | *Bushels.* |
|---|---|
| From Louisville to New Orleans, 19 steamers, consumption per season | 2,015,424 |
| " Louisville to St. Louis, 7 steamers, consumption per season | 600,000 |
| " Cincinnati to St. Louis, Memphis, New Orleans and Nashville, 65 | 1,879,200 |
| " St. Louis to New Orleans, 9 | 867,720 |
| " Memphis to " 4 | 342,400 |
| " Vicksburg to " 4 | 201,600 |
| Red River packets | 75,000 |
| Arkansas " | 100,000 |
| " Natchez to New Orleans 2 | 103,000 |
| " " Bayou Sara 2 | 70,500 |
| Coast Boats 8 | 216,000 |
| From Cumberland and Tennessee rivers to New Orleans | 818,760 |
| Boats plying irregularly from points above Louisville to St. Louis, New Orleans, and regular packets between Louisville, Cumberland and Tennessee rivers | 1,742,780 |
| | 9,000,000 |

☞ The estimate of the consumption of coal, to its equivalent in wood, is as 12 bushels to the cord, which is about a fair estimate when furnaces are properly constructed for burning coal.

The following are some of the advantages to be derived by the use of coal instead of wood.

1st. Coal is less than one half the weight of its equivalent in wood.

2d. Coal will occupy but a small portion of the deck and guards of the steamer, when compared to its equivalent in wood.

3d. The wear and tear of the steamer's guards and decks will be much lessened by the use of coal instead of wood.

4th. By the use of coal, there will be no sparks proceeding from the chimneys or furnaces of steamers, nor any wood pile to catch fire, which is of frequent occurrence in burning wood. It must, therefore, be evident that disasters by fire will be much lessened, particularly with boats carrying *cotton* or other combustible material.

5th. By the entire use of coal, so far as the actual firing is concerned for the generation of steam, not more than one-half the number of firemen would be required when compared with the burning of wood.

6th. With a proper and well arranged plan for taking coal on board of steamers, I think that about *one-half* the time would only be required, than would be necessary for taking on its equivalent of wood.

7th. The saving by the use of coal instead of wood, will of course be the difference in the cost of each, which will be found by investigation to be largely in favor of coal.

Some portions of the above estimate had, of course, to be made without any positive data, but the estimate will, I think, be found nearly correct.

Respectfully,

JOHN SHALLCROSS.

*To Col. E. Webb, Louisville.*

*Recapitulation.*

| | |
|---|---|
| For Steamers as per Capt. Shallcross | 9,000,000 |
| " Sugar Houses | 13,571,376 |
| " New Orleans (city consumption) | 2,:50,000 |
| " " for her steam marine | 3,650,000 |
| " Towns and cities from Cloverport to New Orleans | 3,429,624 |
| " General Government for supplies on the gulf | 3,000,000 |
| | 35,000,000 |

Which, estimating 30 bushels for the ton, gives 1,166,666 tons as the present demand. The increase in consumption in the Eastern States, has been at the rate of 20 per cent. It will be safe to estimate 25 per cent. for the Western, as they are now in a transition state from the use of wood to coal.

| | Tons |
|---|---|
| Sources of supply are at present from the upper Ohio, Pittsburg and vicinity, which has rarely sent over 100,000 tons below the falls of the Ohio, but place it at . . | 150,000 |
| The middle coal fields of the Mississippi valley, including the mines at Cannelton, Hawesville, and vicinity, those of Newburg, Mulford, Bell, Casey and Saline, have not exceeded in amount 240,000 tons, but may safely be estimated for 1856 (calculating the extension of mines, and opening of new ones) at . . . . . | 300,000 |
| | 450,000 |
| To supply a demand of . . . . . | 1,166,666 |
| Leaving deficiency of supply . . . . . | 716,666 |

Which must be drawn from Baltimore and Philadelphia for New Orleans and the Gulf, and upon the rivers wood will still be resorted to. These alternatives make a dear fuel.

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# IRON AND ZINC.

### FORM OF RAILS FOR RAILROADS.

The following article on the best form of rails for railroads, which appeared in the Railroad Advocate, contains so many particulars of interest that we have endeavored to make room for it in these pages:

The following considerations on the best form for rails, may be interesting to your readers. They are the result of an attempt on my part to reconcile an article which appeared in the *Polytechnic Magazine* of April, 1853, to the generally received ideas on the strength of materials.

*Of the Rail Section.*—A good rail must be able to act as a girder or a supporter between the ties, as a lateral guide upon curves, and must possess a top surface of sufficient hardness and size to resist the rolling wear of the wheels.

| | Lbs. per yard. | Tons per mile. |
|---|---|---|
| One square inch of rail section weighs ..... | 9.9 | 15.72 |
| Two square inches weigh ..... | 19.8 | 31.42 |
| Three square inches weigh ..... | 29.7 | 47.14 |
| Four square inches weigh ..... | 39.6 | 62.84 |
| Five square inches weigh ..... | 45.5 | 78.56 |
| Six square inches weigh ..... | 59.4 | 94.28 |
| Seven square inches weigh ..... | 69.3 | 110.00 |
| Eight square inches weigh ..... | 79.2 | 124.50 |
| Nine square inches weigh ..... | 89.1 | 140.01 |
| Ten square inches weigh ..... | 99.0 | 155.57 |
| | Single line of rails. | Double line of rails |

Thus, at $60 per ton, each square inch of section costs $943 20 per mile, or $94,320 per 100 miles.

In the *American Polytechnic Journal*, vol. 1, April, 1858, page 238, appears an article on the form of rails, being extracts from a treatise containing the results of experiments upon the strength of support of rails of different forms made by order of the Prussian Ministry of Public Works.

132 experiments were made upon T, I, and ∩ rails, of twenty different forms and from various factories. Each rail was cut in three pieces, and each piece was tested separately. The bottom flanges of the I rails were cut away, until they became T rails, and when brought to this form, various experiments were made on them.

As the results obtained not only set the theories and practice of Stephenson, Fairbairn, and Hodgekinson, as well as Barlow, and all writers on the

strength of materials, at defiance, but also somewhat contradict themselves, I shall look closely at the conclusions, with a view to seeing what they are worth.

The general deductions from the whole treatise are as follow:

*First.*—The strength of support of I rails when gradually changed to the T form by cutting away the lower flanges, decreases more rapidly than the the weight, the ratio becoming more and more unfavorable, the more the flange is reduced. If the lower flanges were cut entirely off, leaving only the web, the decrease of strength amounts to more than twice the diminution of weight; whence is deduced the general rule—"To put all the material possible in the head and the lower flange, and to reduce to the least possible the area of the web.

*Second.*—In all the trials the rails broke from the bottom up, "evidently from rupture of the lower fibres, and not from compression of the top." Thus the common I rail broke easiest when upside down, because the foot contained more iron than the head, while the T rail broke first when right side up.

*Third.*—The experiments prove that the foot of the I rail offers more resistance than the head. This was also the result when the area of the foot was less than that of the head. That the T rail was strongest upside down.

*Fourth.*—That the weakest form than any other is the ∩.

*Fifth.*—That double head T rails, with the same amount of iron, are less strong than the I rail, with the broad lower flange.

As an application of the results, the treatise establishes two general forms of rails (of the same form generally as in use in the United States), i. e. the I of the following dimensions:

In the first place, the standard width of thread, as determined by the Berlin convention of 1850, is 2.18 Prussian, or 2 1-4 English inches (about the same as given in a former article by me on width of thread).

| | Rail No. 1. | Rail No. 2. |
|---|---|---|
| Weight per yard | 65 lbs. | 70 42 lbs. |
| Whole height | 4.63 in. | 5.15 in. |
| Width of bottom flange | 3.60 in. | 3.60 in. |
| Width of head | 2.25 in. | 2.25 in. |
| Ratio of bottom to top area | 100 to 112 in. | 100 to 108 in. |
| Thickness of vertical web | 0.515 in. | 0.618 in. |

*Sixth.*—The resistance to compression and to extension in wrought-iron is the same, whence the neutral axis passes through the centre of gravity of the rail.

*Seventh.*—The resistance to lateral motion depends on the horizontal dimensions of the head and foot and not of the thickness of the vertical web.

*Eighth.*—The width of the base need not exceed 3½ inches, as this will resist a lateral pressure of 60,000 lbs. on a length of three feet, (the length between the points of fastening,) *and when wider than this, the edge of the flange cannot follow the bending of the web.*

In the London edition, of 1836, of Barlow's Strength of Materials, page 402, in a report of the London and Birmingham Railroad, upon the best form and strength of rails, after a carefully conducted set of experiments, and an elaborate, theoretical deduction of results, the writer comes to the following five sections of rails possessing the maximum strength with the least weight:

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
|---|---|---|---|---|---|
| Height of rail | 4¼ in. | 4½ in. | 4¾ in. | 5 in. | 5 1-10 in. |
| Width at top | 2¼ in. | 2¼ in. | 3¼ in. | 2¼ in. | 2¼ in. |
| Depth at top | 1 in. | 1 in. | 1 in. | 1 in. | 1 in. |
| Thickness of rib | 0.6 in. | 0.75 in. | 0.8 in. | 0.85 in. | 1.0 in. |
| Width of lower flange | 1¼ in. | 1¼ in. | 1¼ in. | 1.06 in. | 1.06 in. |
| Depth of lower flange | 1 in. | 1 in. | 1 in. | 1¼ in. | 1¼ in. |
| Weight per yard | 51.4 lb. | 58.8 lb. | 61.2 lb. | 67.4 lb. | 79 lb. |
| *Dist. cen. to cen. of tie* | 3′ | 3′.9″ | 4′ | 5′ | 6′ |

Mr. Barlow fixes the maximum breadth of the lower web at 1⅝ inches, and the minimum at 1¼ inch; also as remarked in my former article on rails, the same gentleman cut away ¼ of the whole section of the lower flange without weakening the rail at a'l, because, as he says (page 450, Strength of Materials), "Although I am well aware that to extend the breadth of the lower web, and to reduce its depth, would theoretically give the strongest rail, I am quite convinced that it is not so in practice. The lower web comes into play only as it is brought into a state of tension by the action of the centre rib, and although the fibres of the web lying immediately below the centre rib are brought into action by it, and that these fibres excite a similar action laterally in those immediately contiguous to in them, and these again to the next, and so on, so that the extreme fibres of the lower flange do very little.

Again, in determining the form of maximum strength in a 50 lb. rail, he compares the strength of the following sections:

| | | |
|---|---|---|
| *First* —— | Head | 2½ × 1. |
| | Web | .78 in. thick |
| | Whole height | 4.04 in. |
| | Lower web or flange | 1 deep by 1.14 in. wide. |
| *Second* —— | Head | 2½ × 1. |
| | Web | .78. |
| | Whole height | 4.40 in. |
| | No lower web. | |

The 1st being much superior in strength to the 2d.

Let us now look at the Prussian experiments. (See above "second.")

"Thus the I rail broke easiest when upside down, because the foot contained more iron than the head," and *broke always from the bottom up.* Now we are told that the vertical axis passes through the centre of gravity, and from a sketch of the rail we see, that the centre of action of the lower fibres is at a greater distance from the axis than that of the head fibres. Whence the strength of the bottom, even with a less number of fibres, should be at least as great as the top, but as it "always breaks from the bottom up, while the head is not compressed," it is plain that wrought iron resists considerably *more* compression than it does extension. But we are just after told that the resistances are equal, and towards the close of the article, that the foot offers more resistance to breaking than the head, even when smaller.

Now I am inclined to think that the reason why the I rail is the strongest when in its sixth position, is because the head is more able to resist compression than the foot, and that the cause for the weakness in a reversed position is because the foot is less strong than the head; to be sure, the centre of action in the foot is at a greater distance than the same point in the head, but at the same time the material in the head is much more completely connected with the vertical web, and much better able to follow its deflection. Even the Prussian experiments show that the flange when 4 inches wide is not able to follow the action of the web.

Again, we are told that the T rail is strongest upside down; so it should be according to my ideas; the centre of gravity of a T rail, 8½ inches high of the common form, is 10-36 of the depth from the top; the centre of action of the top is just one half as far from the neutral axis of the rail, as is that of the bottom, whence the bottom is of course stronger than the top, and able to resist more compression; and as the top side resists the compression, the strongest form is upside down. Q. E. D. (see above *Fourth.*)

There are two reasons why the ∩ rail should be the weakest form; (though, according to the Prussian experiments, it ought not to be, as long as there is more material in the lower part than there is in the I rail.) The first reason is that the area of the head is too small; and the second, that the action of the flanges is so very indirect. It gives a very broad base, but who has ever heard of lateral failure of our I rail, 4 × 4 inches?

It will be observed that in all of Mr. Barlow's rails, the head contains full one half of the whole material.

The results of the experiments of Mr. Fairbairn, upon the traverse strength of wrought iron, are, that to get the strongest bar, with the least material; the area of the top flange must be double that of the bottom one; and that the relative resistance in wrought iron to extension and compression is nearly as 2 to 1. Mr. Hodgekinson's results for cast iron make the following; compression to extension as 6 to 1, whence he finds the areas of the flanges, thus top to bottom as 1 to 6.

Now let us put together all of the results that will bear examination, and see what section we get for the rail.

*The Head.*—Barlow limits the breadth at 2½ inches. The Berlin convention at 2¼ inches. D. K. Clark (by W. B. Adams) at 2½; and all three of the above authorities recommend supporting the edges of the head well from the rib.

*The Vertical Web.*—The Prussian commission make the thickness for a rail 4 inches high, ½ inch, and a rail 4½ inches high, 0.6 inch. ($\frac{6}{10}$) Barlow makes it $\frac{6}{10}$ inch, for a height of 4½ inches, for 4⅝ inches height, 0.75 inch; and for 4¾ inches high, 0.8 inch.

*The Bottom Flange.*—The use of this is more for lateral fastening than for supporting strength. The Prussians make 3½ inches ample for a rail 5 inches high. The edge for ¼ or ¾ should be horizontal or parallel with the base to allow the spike to have a good bearing.

*Of the Inclination.*—As the tread of the wheel tire is conical, so should the top of the rail be inclined to fit the same; this may be done in two manners, by placing the rail base level, inclining the vertical axis of the cross section of the rail, and making the head square with that axis, or by making the rail true and inclining its base by cutting the sleeper, or by a wedge between the rail and tie.

*Of the Head Curvature.*—If the head is perfectly flat, and the tie does not happen to fit it exactly, the wheel will bear entirely on one edge, and soon destroy the rail; to remedy this a slight convexity must be given to the top. Mr. Clark recommends a radius from 10 to 12 inches.

*Of the Vertical Depth (or Height) of Rail.*—Mr. Barlow's general results are as follows:

| Distance from inside to inside of tie. | Height. |
|---|---|
| 3 feet | 4¼ inches. |
| 3 feet, 9 inches | 4⅝ inches. |
| 4 feet | 4¾ inches. |
| 5 feet | 5 inches. |
| 6 feet | 5 1-10 inches. |

And from this formula, we add the two heights below:

| | |
|---|---|
| 2 feet, 9 inches | 4⅛ inches. |
| 2 feet, 6 inches | 5 inches. |

With the above dimensions and joining the curve of the head to the rib at 2¼ inches from the top of the rail, we obtain a strong and well shaped rail with the least material possible.

*Note* 1.—The neutral axis in any bar, is not a fixed line, but changes its position with every change of position of the bar. Thus in a bar whose section is a triangle, base down, the neutral axis for wrought iron is very near the bottom; but, with the base up, it is nearly half the depth from the upper surface.

*Note* 2.—The amount of inclination or bevel, to be given to the cross section of the rail, depends on the cone given to the wheel tires; this latter depends on the gauge of the road.

*Of the Rail Joints.*—The weakest part of the track is the point where the joint occurs in the rail; here the whole strain from the engine is placed upon the tie, and goes thence to the ground, if there happens to be any beneath the sleeper. To see where the most wear and tear occurs, and to see what causes the shocks to machinery, and the continual bump—bump, beneath the cars, we have only to look at the end of the rails that have been laid a few years,

or to ride a few miles on the back end of the rear car. The complete remedy for all defects from this cause, is to join the rail ends in such a manner as to make the rail as strong at that point as at any other; in fact it should be stronger, as the momentum caused by the passing of the engine at that place is greater than at any other. The method in use in England is perfectly effectual and quite cheap, called "fishing." It was first applied in —— by —— upon the —— Railroad, and has since been almost universally adopted. I saw the invention noticed some time since in an American paper as something new, but it is not; it has been found to succeed perfectly after a long and fair trial. It consists in bolting a plate $2\frac{1}{2}$ feet long, $2\frac{1}{2}$ or 3 inches wide, and $\frac{1}{4}$ or $\frac{1}{3}$ inch thick, to the ends of both rails; making the joint, one plate being each side; the plates being convexed a little from the rail, that screwing upon the bolts may at all times tighten them, and that they shall always be tight during the vibration of the rails, and not work loose. In this arrangement, there is no tie immediately below the joint, but the latter lies midway between two sleepers. Another very good way of fishing a joint, would be to place a piece of I angle iron beneath the lower flange of the rail, bolting it firmly to both rails. This is a much better manner of forming a continuous rail, than by dividing the rail either horizontally or vertically, as we thus prevent entirely the joint actions of compression and extension. In bolting rails together at the ends, the bolt holes must either be cut a little larger than the rivets or bolts, or else be made oval, to allow for expansion and contraction.

*Of Frogs.*—The weakest point of a line of rails is of course at the frog, as at that point occur two joints, and one break in the rails, at the point. If the method of welding the ends of the crossing rails themselves, and omitting altogether the casting, were fitted with a piece of plate or a strong timber underneath, able to make up for want of strength at the joints, everything would seem to be accomplished.

Nothing aids more the proper accomplishment of any object than a correct idea of what is wanted. The improvers in "permanent way," may direct their efforts, properly. I add the definition of "permanent way," from page 279 of Clark's Railroad machinery.

"The principal requirements of permanent way are, that it be well drained, and especially in contiguity to the substructure. That the weight and damaging power of the engines and rolling stock should be considered as the data for calculation. That the strength, hardness, and tenacity of rails, and the immobility of the sub-structure should be adapted for the hardest work to which the railway is to be subjected. That the sub-structure should have an amount of bearing surface proportioned to the load to be borne, and the nature of the rail or ballast; and a sufficiently firm hold in the ground to prevent looseness or lateral movement from the side lurches of the engines and trains. That the rails should possess so much vertical and lateral stiffness either in themselves or by their fastenings, as to prevent all deflection, and have sufficient hardness of surface not to laminate or to disintegrate beneath the rolling loads; and have sufficient breadth or tread surface to diminish the effect of the crushing power of the wheels. They should be as smooth as possible to prevent concussion, and be laid at the proper angle, and the curves regularly bent, so as to insure the accurate tread of the wheels, while the joints should be so made, that the rails may practically become continuous bars, yet with freedom to expand and contract without being too loose. And with all this there should be interposed between the rails and the solid ground, some medium sufficiently elastic to absorb the effect of the blows of the wheels, without being crushed or forced down into the ballast, and yet stiff enough to keep the upper surface of the rails in a uniform plane.

Of the Life of Rails.—The time which a rail will last, depends upon its form and size, and the number, and weight, and velocity of engines and trains passing over it. The durability is independent of time, and depends upon the amount of work done. The repairs of the superstructure depending upon flaws in the iron and other physical defects, will be greater at the commencement of operations, than at any other time; after the first one or two years

the regular depreciation begins. The first Liverpool and Manchester rail weighed 85 lbs. per yard, and the locomotive 7½ tons; as the railroad traffic increased, so did the weight of engines, and a corresponding increase in the strength and weight of rails was rendered necessary. In 1831, the even average weight of engines with a tender was 18 tons; in 1855, the maximum engine with fuel, and water, and tender, 60 tons, and in like manner the weight of rails increased from 35 to 85 lbs. per yard. Messrs. Stevenson & Locke recommended, in their Report to the London and North-Western Railroad, of 1849, to adopt for the future an 85 lb. rail.

Upon the railroads of Belgium is used a 55 and 64 lb. rail, but it is asserted that an 80 lb. rail would allow of ten times more traffic.

Mr. Belpaire, of the Belgian Engineers, concludes from many extensive experiments. that in 60 miles each engine abrades 2.2 lbs.; each empty car, 4½ oz., and each ton of load ½ oz. per 60 miles, the amounts being in direct ratio to the several weights. Capt. Huish, of the London and North-Western road (England,) estimates (see Report of April, 1849) that 50 trains per day, or 18,250 per annum, or in all 365,000 trains in 20 years, would wear out a 70 lb. rail. The Belgian Engineers have concluded that 3000 trains per annum, for 120 years, or in all 360,000 trains, would wear out a 55 lb. rail. The coincidence of the results is very remarkable, as Capt. Huish was ignorant of the result of the Belgians; the difference (5,000 trains) in favor of the Belgian roads, is owing to the heavier engines in use upon the English railroads. As a general thing, American rails will be less durable than those of Europe, on account of the unpermanent character of the permanent way. If, at any points of the road, there are rails which are subjected to more than usual wear, such as those at termini stations, they should, of course, be heavier than those elsewhere.

The financial expedient proper to meet the depreciation of rails is evident; knowing the maximum cost of relaying the track when it shall be worn out, the amount of an annuity must be calculated, which at the end of the life of the rails will equal the cost of relaying the track, and the sum must be carefully taken from the revenue and properly invested, to meet the requirement.—*R. R. Advocate.*

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### AMMONIA; TO MAKE IT IN IRON WORKS.

The following, from the London *Mining Journal*, is worthy of consideration by our iron manufacturers:—"The vapors which escape from iron blast furnaces may be regarded simply as the atmosphere highly charged with carbon, or as a mixture of carbonic oxide, cyanogen, and nitrogen. When steam, at a sufficiently high temperature, and air excluded, is mingled with these gases, the oxygen of the steam decomposes the cyanogen, and converts the carbonic oxide into carbonic acid, while the hydrogen and nitrogen combine to form ammonia; thus carbonate of ammonia will result; but as it may prove difficult to condense this effectually, if the vapor of ammonia were conveyed into a chamber charged with an insoluble lumpy material, so arranged that the ammonia, in ascending, would come in contact with the cold solution of salt trickling down, carbonate of soda and muriate of ammonia might be at once obtained. If, however, an ample supply of sulphate of iron could be procured, it would be more advisable to fix the ammonia by means of sulphuric acid expelled from sulphate of iron; because, at the same time, pure oxide of iron would be produced, which would prove valuable in the subseqnent forging of iron. Alkali refuse should be composed of sulphuret of calcium and coke dust. When this is acted upon by steam with sufficient heat, the oxygen of the steam converts the calcium into lime, while the sulphur and hydrogen pass off as sulphuretted hydrogen. When the latter is mingled with the vapors from a dense purely carbonaceous fire, consisting of carbonic oxide and nitrogen, the latter combines with the sulphuretted hydrogen, and forms sulphuret of ammonia. If these vapors are then partially cooled down, and a large

quantity of cold air admitted, the carbonic oxide becoming carbonic acid, combines with the ammonia, and disengages sulphur; thus carbonate of ammonia and sublimed sulphur might be obtained. If, on the other hand, the heat of the vapors is maintained, and a large quantity of heated air thrown in, the sulphuret of ammonia is converted into sulphite, which rapidly passes into sulphate of ammonia, by means of which more salt may be decomposed; and thus alkali refuse may be brought to yield sulphate of soda, muriate of ammonia, and carbonized lime dust. This latter material will be valuable in agriculture; it should be worked into the land when preparing it for seed, muriate of ammonia being afterwards applied to the growing crop, when the first shower of rain will carry it into the soil, when carbonate of ammonia will be disengaged in direct contact with the root of the plant. By treating gypsum as sulphate of lime, with small coal and high heat in a reverberatory furnace, it would be reduced to sulphuret of calcium, and may, by a similar mode of treatment, yield the same product as alkali refuse.

"T. H. LEIGHTON."

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### COMPOSITION AND FORMATION OF STEEL.

Dr. Jackson gave an account of some researches into the composition and manner of formation of different kinds of steel. As commonly known, steel is a combination of carbon and iron, made by heating flat bars of pure iron in combination with charcoal. The carbon is first converted into oxide of carbon, and then unites with the iron as carburet. The result of this process is known as blistered steel, from the bubbles generated by gases upon its surface. Shear steel consists of parallel plates of pure iron and steel welded by folding, and uniting the bars of blistered steel. Cast steel is fused in pots of the most refractory material, and differs from cast iron, which likewise contains carbon, in this respect, that cast iron is a mixture of coarsely aggregated matters, graphite and iron, whilst cast steel is a chemical combination of carbon and iron.

From the researches of Berthier it is known that manganese will form an alloy with iron. When iron is mingled with a considerable proportion of manganese, a brittle compound results; but when combined with a very small proportion of manganese, a steel of very fine quality is obtained, which has this advantage over carbon steel; carbon steel becomes coarse when tempered in thick masses, from segregation of the particles of carbon; but no such trouble arises with manganesian steel. Parties in England have lately introduced excellent wire for pianoforte strings, made of this kind of steel, as well as for cutting instruments and other purposes. In the wire, Dr. Jackson has found 1½ per cent. of manganese, and has established the fact that it resists, to a very remarkable degree, the action of hydrochloric acid. Sixteen years since, Franklinite Iron was manufactured by Mr. Osborn into very hard and fine steel. This steel required tempering at a lower heat than carbon steel. Many of our manganesian irons might be manufactured into steel by the simple process of fusion, and a steel of uniform character might be made without previous cementation with carbon.—*Boston Natural Historical Soc.*

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### THE IRON TRADE.

According to calculation in the Pittsburg *Post*, the iron manufacturers of this country have a sure demand before them of nearly $300,000,000 for fabrics to be turned out from their manufactories—a demand that will require all, and more than all their capacity to supply fast enough. The calculation upon which the statements are based, is the extent of railroad now in course of construction. With one hundred tons per mile, single track, it will require, 1,300,000 tons of iron rail to complete the thirteen thousand miles of railroad, either in progress or which will be in progress ere long, including the Pacific Railroad. At $50 per ton this would require an outlay of $65,000,000 for

single tracks alone. But many of these roads will be double tracks, besides turnouts, &c. Then follows a vast outlay for cars, locomotives, and other iron works about such roads. And it may be fairly estimated that all the iron for them will cost not less than $150,000,000. Ocean and inland steamers, iron ships, manufacturing machinery, iron buildings, and all the other innumerable uses to which iron is applied will require as much more; making an aggregate sure demand for $300,000,000 worth of iron. Besides which, many other railways will be chartered and undertaken every year, to keep up a steady demand to that amount for many years to come; if not a constantly increasing amount. With the high price of iron abroad and the demand at home, the iron manufacturers have a tolerable fair prospect of profit before them.

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THE PRESENT POSITION OF THE IRON MANUFACTURE OF GREAT BRITAIN.

A paper was recently read by Mr. J. K. Blackwell before the Society of Arts on "The Present Position of the Iron Industry of Great Britain, with reference to that of other countries," which contains some interesting particulars.

Mr. Blackwell sets the total annual production of pig or crude iron at 6,000,000 tons, of which Great Britain produces 3,000,000, France 750,000, the United States 750,000, Prussia 300,000, Austria 250,000, Belgium 200,000, Russia 200,000, Sweden 150,000, the smaller German States 100,000, and other countries 300,000.

The ores of iron may be divided into five great classes—the magnetic oxides; the anhydrous hematites, with micaceous and specular ores; the crystalline carbonates, or spathose ores; the earthy carbonates, including the blackband; and the hydrated hematites, and brown iron ores. Iron is also found in the state of a silicate, either alone, or associated with magnesia, lime, or alumina, and united with sulphur, phosphorus, arsenic, and occasionally with other metals. The magnetic oxides are found principally in the gneissose and other primary rocks; the anhydrous hematites, the soft red oxides, and specular and micaceous ores in the transition formations; the spathose or crystallized carbonates range through the same formations. The earthy carbonates, evidently of sedimentary origin, are spread in courses of nodules throughout most of the recent formations, from the coal measures upwards; the local deposits of hydrated peroxides are often covered up by clay and sand, and the ore often assumes the pisolitic form.

In Great Britain he thinks that the most favorable localities for the iron industry are already fully occupied, but that in Ireland there exist immense deposits of clay carbonate of excellent quality, which are now entirely unworked, and he suggests it as a very important subject for inquiry whether the immense resources of vegetable fuel in the form of peat with which Ireland abounds, especially in Eastern Connaught, the region in which these ores exist so largely, might not be advantageously applied to the production of first-rate iron from them. He enforces this suggestion by stating that pig iron is smelted with carbonized peat in Bohemia.

The iron produced in France is smelted in nearly equal proportion with coke and charcoal; that a large proportion of the charcoal pig iron is subsequently converted into bar iron solely with charcoal; and that the charcoal pig iron is for the most part made in close proximity to some of the most important coalfields in France. This latter consideration points, in Mr. Blackwell's opinion, to an early transformation in the French iron industry. From the limited extent of Belgium he anticipates that the production of iron will remain nearly stationary there; whereas in Prussia he states that it is rapidly increasing, the chief obstacles being the nature of her widely spread, ill connected territories, and the want of facilities of intercommunication and of

access to markets. The latter class of drawbacks he notices as restricting the production in Styria, Carinthia and Bohemia: and from similar causes, and the absence of mineral fuel, he anticipates that the iron manufacture in Russia and Sweden—neither of which countries possesses mineral fuel conveniently situated—will long remain comparatively stationary. He, however, remarks that the valuable deposits of ore in Sweden—might probably be rendered much more valuable if the laws prohibiting its export were repealed.

The iron industry of the United States is already highly important, and capable of great extension, which must in a great degree be determined by the available means of transport, and the facility with which the ore can be brought in proximity with the fuel. Iron ores of various classes are largely and widely developed, magnetic oxides accompanying the primary formations which skirt the Atlantic coast, and following them in their western prolongation through the region of the great lakes. Anhydrous hematites occur extensively in the Silurian and Devonian formations. Clay carbonates, frequently changed into hydrated peroxides, occur near the base of the carboniferous series in some localities, and sparingly also in the coal measures themselves—as for example, in the Maryland coal basin, and near Hanging Rock, in Ohio, in the great western Pennsylvanian field. This class of ores has not, however, hitherto been found abundantly either in the anthracite coal fields east of the Alleghanies, or in the three great bituminous coal fields situated in the Mississippi Valley, west of that range of mountains—that is, in the great coal regions of Western Pennsylvania, Virginia, and Ohio, of Illinois, or of Missouri and Arkansas. But these enormous carboniferous regions have hitherto been so imperfectly explored, that we do not know with certainty to what extent these ores may hereafter be found to exist in them.

He next proceeds to an examination of the various processes adopted in the manufacture of iron and to their susceptibility of improvement. Mr. Blackwell says that the differences in chemical nature of the various elements forming, on the one hand vegetable, and on the other mineral fuel, are only in degree, and not in kind, except in so far as regards the composition of the earthy residuum of ashes left after the volatilation of the other elements. It may therefore be in the different nature of the substances present in the ashes of wood and of coal that we must seek for the explanation of the causes which produce such a widely different quality in iron smelted with these two species of fuel. He considers that sufficient attention has not been hitherto paid to this subject, or to the mechanical operations by which a large part of the earthy impurities of all coal seams of a caking nature, might be separated from them before they are converted into coke. Again, he says that, notwithstanding the great extent to which raw coal and partially torrefied wood have been long used in the blast furnaces both in England and abroad, on a careful consideration of the process to which both coal and wood must be subjected before the carbon they contain can be utilized in the reactions of the furnace, it appears that their carbonization may be effected with most economy, and that the quality of the charcoal or coke which results from this process will be best, when effected in close ovens prior to the introduction of the fuel into the blast furnaces, and not within the furnace itself. After pointing out the source of some of the losses sustained by iron masters in England and in South Wales, especially from imperfect smelting, he remarks that much controversy has taken place with respect to the difference in quality supposed to exist between pig iron smelted with cold and with hot blast. It was generally considered that the pig iron smelted with hot was inferior in quality to that produced with cold air, but he had attributed this impression to ignorance of the facts of the case. Furnaces blown with heated air exerted so great a reducing power, that refractory ores calculated to produce inferior iron were now easily smelted, and thus had arisen the opinion alluded to. At the same time, he admitted that the more elevated temperature of the hot-blast furnace had a tendency in a slight degree to increase the quantity of silicum and other cognate metals which formed alloys with pig iron in the smelting process.

In treating of the operations for converting carbonized crude iron into malleable, he mentioned that at several works on the continent the attempt to arrest the process of decarburation in the puddling or boiling furnace at that point at which the conversion has proceeded so far as to leave the iron in the state of steel or subcarburet, was believed to have been successful, and that a valuable natural or puddled steel, not requiring cementation before conversion into refined cast or steel, had been the result. He cited as a proof of the faultiness of the present modes of operating, that in some of the largest iron-making districts of Great Britain, the production of one ton of inferior wrought iron was only obtained by the consumption of 1 1-2 tons of pig iron. The crude iron from which wrought iron of the best quality is produced, is that possessing a medium degree of carburation, usually termed gray pig iron, while iron which possesses an inferior degree of fluidity is what is generally used for the manufacture of wrought iron, especially when the conversion is effected by the single operation of boiling in the puddling furnace; but it is always more impure than gray, and does not produce the best wrought iron. In those countries where the pig iron is smelted with charcoal, and where coal is available for conversion into malleable iron, the charcoal refinery is generally abandoned for the puddling furnace, it being found that the quality of the iron is sufficiently insured by its previous treatment. In Great Britain, where the smelting process is almost exclusively conducted with coal or coke, nearly the same result is obtained with reference to the quality of the bar iron produced by the treatment of the pig iron in the charcoal refinery with charcoal; it therefore becomes an important subject for investigation, to ascertain what are the precise causes to which this amelioration of quality from the use of vegetable fuel is due, when used in the treatment of iron in processes which have no analogy to each other. He considers that the circumstances of the two cases point to the possibility, that the eliminated effect exercised as fluxes in both instances by the ashes of the vegetable fuel employed, may have some influence in producing this improvement in quality, and that, should such be the case, we may replace charcoal as fuel with advantage by artificial fluxes producing an equivalent effect. The charcoal refinery in general use in those countries where mineral fuel is not accessible for the conversion of crude into malleable iron, is still extensively employed in Great Britain when it is desired to produce iron of the best quality. Mr. Blackwell points out that gray pig iron smelted with coke may be converted into malleable iron by the boiling process, thereby avoiding the serious waste from oxidation in the coke refinery, and it becomes important to inquire whether any ameliorations can be introduced which would enable it to be more universally adopted than it hitherto has been. He remarked, however, in general terms, that the principal mechanical agents in these operations are the hammer and the rolls, and that it is by a proper combination of both that all the requisite qualities of well-manufactured iron can be obtained. He observed that in this country latterly there had been a tendency to supersede the use of the hammer by that of the rolls, not only in small sizes, where the immense command of power rendered it practicable to do so, but in large sizes also, as for instance, rails, large bars, plates, and thick sheet iron, where it was not practicable, if soundness was to be secured.

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### MANUFACTURE OF RAILROAD IRON.

The manufacture of railroad iron is rapidly growing to be one of the most important branches of the iron industry of this country, if not indeed the most important. The extent and certainty of the market are manifest. Some details of its present importance will be found in the February number of this Magazine. To the iron manufacturer, this is a subject of importance. To the railroad director, the point of prominent consideration is the quality of the

rails. Herein, both the manufacturer and the director are jointly interested. Here both parties meet. It is likewise a subject peculiarly appropriate to these pages, and we shall endeavor to present all the information upon it which may come within our reach.

The experience of the Reading Railroad, one of the largest avenues for transportation in the country is found in the following fact:—

As ten thousand wheels in the season of active business daily roll upon it, it was deemed true economy to relay a large portion of this track, in such manner and of such material as should secure the machinery from unnecessary wear, and to make the roadway itself as perfect and as permanent as possible. The experience of this Company as communicated in previous reports, and confirmed by each year's traffic, is, that upon the quality of the iron rather than its weight, the durability will depend. Thus the rails first used, weighing 45 lbs. to the yard, and made of carefully prepared reheated and refined iron, have been found far more permanent and serviceable than those weighing one third more, but manufactured from iron of inferior or different qualities. The new rails of a weight of 68 lbs. are manufactured of the best reheated iron throughout, and the additional sum expended to secure this description and quality of material, nearly equals the whole excess of expenditure on account of renewal fund.

Mr. J. H. Grant, Superintendent of the Nashville and Chattanooga Road, thus speaks of the wear of their rails:—

The duration of rails is variously estimated by Engineers and Superintendents; of course depending upon the *tonnage* and *speed* that is rolled over them. The Engineer of the State of New York, in his report to the Legislature for 1854–5, states that the depreciation of rails (after allowing for the value of the old material) is equal to the cost of an entire renewal once in fourteen years. Capt. Geo. B. McClellan, in his report to the Secretary of War, states that "the average durability of iron in Massachusetts is not more than 10 years. Old rails are re-rolled at a cost of $25 per ton." The U rail laid on continuous bearing timbers between Madison and Social Circle, on the Georgia Railroad, under my supervision in 1845, are worn out and replaced with new rails—(the balance to Atlanta has to be taken up and replaced with new rails next year)—giving them an average duration of 10 years. I do not think it would be safe to make any calculations upon a longer duration than 14 years of our rails laid on continuous bearings, and 10 years for those laid on cross-ties. The average last of locomotives on Southern roads may be set down at 10 years, and cars at 8 years.

From the foregoing, you will be able to form a very correct idea of the rate our rail and machinery are wearing out.

In this connection, the following remarks from the *Railway Times* are important, for to a good *quality* of rail all roads must ultimately come.

A depreciation of forty or fifty per cent. on rails is a serious charge on the net income, but some of our railways have had to meet it. We have known instances where a cargo of iron rails after arrival, was rejected by the inspector, and was afterwards sold at even a higher figure by the importer to one of our new Western companies. The inspector took some pains to look after the fate of that cargo of rails, and he found that some portions of it were taken up within the first year, a large proportion of it during the second year, and at the end of three years not a rail of it was in use on the main track. Now it is acknowledged by all competent railway managers, that a good rail should last from eight to twelve years, passing about the average tonnage of our New-England trunk roads. On a leading road out of Boston some of the rails, we have been told, have been in use some fifteen years on the main track, and are now strong and serviceable. A leading railway manager of the West gives

the annual depreciation of "rails, spikes and chairs," at five per cent. One of our leading New England managers gives the annual wear of the rail at eight per cent. Another Western manager at twelve per cent. All these gentlemen are attentive observers of what is passing on their own lines, and their judgment is modified and controlled by what they themselves see. Any one who will give the requisite attention to the matter, will find that the annual depreciation of rails on the different roads, varies from five to fifty per cent. If the depreciation is five per cent., your rail will last twenty years; if fifty per cent., two years. This broad statement of facts will show our railway directors and shareholders of how much importance it is that only good rails should be bought. The *quality* of the rail, and not its price, is the great thing to be considered in making purchases. We are not alone in the opinion that buying poor iron has foiled many of our railway enterprises. A gentleman connected with the management of one of our leading lines of railway, lately told us that he knew the annual *depreciation of the rails*, on a certain line of road, had been over fifty per cent. of the gross earnings for a given period,—and we have no doubt that the statement is true. Had not the practice of repairing and patching rails been pretty well adopted on many of our roads, we fully believe they must ere this have stopped running. Without funds or credit the companies have been compelled to study economy and care, and it is only from this that they have been able to keep their trains in motion. A *good* rail will last from twelve to fifteen years, a poor rail will last from one to three years. The comparative economy of buying poor or good rails can be easily calculated. The matter of the *quality* of rails is a matter of life and death to our railways. There are not a dozen companies in the country that can iron their road more than twice with the poor article, and keep their dividends or their credit up.

The cost of manufacturing in Tennessee, is thus estimated by Mr. W. F. Beach.

The following estimate has been prepared under the eyes of three iron-masters.

The weight of a rail of 63 pounds to the yard is at the rate of 100 tons to a mile; this for 600 miles requires 60,000 tons, which, at 75 dollars a ton, amounts to four and a half millions of dollars. If this iron should be made in three years, 20,000 tons would have to be made annually; this would require for its manufacture from the pig:

| | |
|---|---|
| 60 puddling furnaces at 800 | $48,000 |
| 2 forge mills with trip-hammer | 30,000 |
| Welding furnace and steam hammer | 5,000 |
| 6 heating furnaces at 800 | 4,800 |
| 2 rolling mills | 100,000 |
| Contingencies | 12,200 |
| | $200,000 |

If the iron is to be made from the ore, add for 10 large blast furnaces at $15,000, $150,000. Numbers of persons can be found, who, for the profits on a contract of four millions, will expend two or even four hundred thousand dollars.

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### INVENTION AND DISCOVERIES OF M. CHENOT.

In a biographical notice of Adrien Chenot, a fertile inventor, the originator of a new system of Metallurgy, who died in November, 1855, Silliman's Journal of Art and Science thus describes some of his inventions and discoveries connected with iron, &c.

The inventions and discoveries of M. Chenot have a universal importance; and yet they are not known as they merit to be, as he had not the talent of

pushing his labors into notice. In 1836 he prepared some of the metals in the spongy state, and made known their curious properties. He afterwards applied this property to the treatment of ores and the fabrication of steel, and raised this part of metallurgy from the empiricism in which it had hitherto remained. He pointed out a method of determining which ores are the best for steel, showing that in case of two ores of the same composition, the measure of value was marked by the relative quantity of cement which the metal that the ore affords, will take up without becoming brittle; thus, between the ore of the Ural and that of Elba, the former will imbibe 6 p. c. of carbon, without losing its malleability, while the latter is brittle with only 4 p. c. of carbon. This property of retaining more carbon he attributes to a peculiar earth which has some analogies with alumina, and which is found in all ores that furnish good steel. The method of cementation is simple; it is only necessary to plunge the iron sponge into tar, oil, or some other liquid highly carbonized, and then heat to fusion.

One consequence of his labors is the application of electricity to the cleaning of iron ores. The machine works automatically, and will separate many tons of ore per day, cleaning it perfectly from the earthy gangue which absorbs so much of the combustible employed in the furnaces.

The reduction of the metallic oxides by the oxide of carbon, or by the mixture of this oxide with hydrogen, such as is obtained in decomposing the vapor of water by coal at a red heat, will sooner or later transform the industry of the metals. In treating sulphate of lead by the iron sponge, sulphate of iron is obtained along with lead in the metallic state. By impregnating the iron sponge with boracic acid and heating, excellent steel is obtained, which contains no carbon; and steel of another quality is formed by adding the ores of aluminium. Long before the bruit which has been made with regard to this last metal, M. Chenot insisted upon the part which aluminium acts in metallurgy and upon the alloys which it forms with iron.

In Chenot's view, the quality of iron depends more on the region from which it comes than upon the manner of treating the ores; the locality of the ore bed has as much influence on the iron, and especially the steel, as that of the vineyard on the wine it affords.

The manufacture of the sponge can be made with all kinds of combustibles; even those which are rejected in other industrial pursuits may be employed. He first sought to normalize combustibles by getting rid of the sulphur, phosphorus, and arsenic, which affect the quality of the iron. This he accomplished by treating the ores with common salt or an alkali. His first attempts date from 1850. In 1851 he made some trials in the Catalan Forges of Ariège. Having been denounced after the events of December, 1851, as a suspicious person, by a jealous superintendent of iron works, M. Chenot was taken from his labors and thrown into prison; and this man, so useful, mild, loyal and honest, would have been transported with many other victims to Cayenne, were it not for the intervention of some influential friends.

The purification of combustibles, by means of common salt, has lately been undertaken in England; and it has been stated that in the process the sulphuret of iron is transformed into chloride of iron, which is volatilized, and sulphuret of sodium which flows off with the scoria; but this practice is evidently bad, for at a high temperature sulphuret of sodium is decomposed by iron.

Another invention, full of promise, due to M. Chenot, is the application of the hydraulic press to the compression and moulding of metallic substances. By compressing the sponges in the cold, he obtained results which dispense with the employment of high temperatures, and produce an economy of combustible amounting nearly to 75 per cent. He was convinced that with sufficient force the moulding of metals in the cold would become almost universal, even for forms the most complicated, and with various combinations of metals, whatever art may require, so that copper, iron, steel, gold, silver, etc., may be combined in any way that may be desired.

MACKENZIE'S BLOWING MACHINE.

There is in daily operation at the foundery of Messrs. R. Hoe & Co. in this city, and at several founderies in Jersey City, a rotary machine for forcing air much superior to any before introduced. It is the invention of Mr. Philip W. Mackenzie of the latter place, and has now been practically tested some eighteen months. The blowers now in use are of two classes: the bellows and the fan. The fan blower in various forms and proportions is driven at a high velocity, and drives a large volume of air with a force sufficient for ventilating mines or buildings, blowing away the chaff in winnowing grain, or enlivening the fires of a blacksmith's open forge. But where the air is to be driven with any considerable pressure or force, as in supplying divers at considerable depths in the sea, or blowing blast furnaces for making iron, some form of the bellows or of the pumping cylinder is almost invariably employed. The interior of a blast furnace is filled some forty feet in height with a mingled mass of ore, coal, and limestone, and the blast forced in near the base requires a pressure of from one-and-a-half to nine pounds per square inch to rise through it. Fan blowers rarely yield a pressure of more than from three to ten ounces per square inch, but the pumping cylinder may compress the elastic fluid to any extent desired. The fan is, however, much smaller and cheaper—a fact which has induced an attempt to increase the pressure by blowing from one fan into another, thus raising the pressure a few inches with each lift. This is an English plan, and the effect observed was an increase of pressure pretty nearly equal for each fan passed through. In this country our blast furnaces are generally blown by pumping, and our cupola furnaces, which require less pressure, by fans.

Mackenzie's blower includes two cylinders placed eccentrically, one within the other. The outer one is fixed, but the inner revolves, and in doing so protrudes blades or wings to such an extent as always to just wipe the interior of the first. The ends being closed, and two liberal openings made in the sides of the external cylinder, the air is drawn in through one opening and expelled through the other, whatever may be the degree of resistance interposed.

The fixed cylinder or external case of the blower at Hoe's foundery is forty inches in diameter, and thirty-six inches long. The internal cylinder is thirty inches in diameter, and carries three wings of half-inch boiler-iron. The centre on which the internal cylinder revolves is five inches from the true centre of the case, and the surfaces, consequently, are in contact at one point, while on the opposite side they are ten inches apart. The protrusion and withdrawal of the wings is performed by a very simple device, in which consists the chief novelty of the invention as compared with other winged rotary devices. The inner cylinder is penetrated by a fixed shaft, which shaft is bent to one side after passing through the end, until it coincides with the centre of the large cylinder or outer case. To this portion of the fixed shaft the wings are connected, and their extremities are thus made to travel in a perfect circle in close contact with the inside of the outer case. The inner cylinder thus gives motion to the wings, and in every revolution its periphery is slid outward and again contracted upon them. It is not strictly true that the wings are thrust outward and withdrawn, although it is so relatively to the inner cylinder. The passage of the wings through the latter is packed in a very ingenious and perfect manner, to allow for the varying angle which it continually assumes, and the whole machine appears to involve but a moderate degree of cost, either for construction or repairs The inlet and outlet openings are made, of course, near the point where the two cylindric surfaces are in contact; and the blast of wind is very nearly steady and continuous, a slight fluctuation of pressure occurring with the commencement of each wing to cross the delivery opening. This fluctuation is due to the regurgitation or back flow of the air until the space between the wings is compressed to the *extent required* for delivery. The air in the blower at Hoe's is compressed to

about one pound plus pressure, and the variation alluded to in the intensity of the blast is too slight to be any annoyance. The blower described is driven about seventy-five turns per minute, and requires only from one fifth to one quarter the power formerly consumed in obtaining the same effect from a very large and well constructed fan. About fourteen horse-power was formerly consumed in blowing a single cupola, the amount being measured by a steam-engine-indicator. The Jersey City founderies, which previously employed a lower pressure of blast, have experienced a smaller saving of power, but have realized a very considerable economy of fuel in the cupola—the amount required per ton for melting being some twenty or thirty per cent. less than before.

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### MANUFACTURE OF IRON AND STEEL.

An invention for the reduction or smelting, by an improved system, of iron ores, for smelting and puddling pig and plate-iron, and for manufacturing bar, plate, rod, sheet, and other descriptions of iron intended to be afterwards converted into steel, has been patented by Mr. Robert McCall, of Pallas-Kenry, Limerick. For the purposes of this invention, the patentee employs a close furnace, instead of the open furnaces hitherto employed in such manufacture; and to the furnace valves are adapted, for regulating the heat required for the smelting the ores therein; and the smoke and gases from the furnace are employed for drying purposes (such as drying of the fuel), by conducting off the same through a pipe inserted into the side of the furnace near the top thereof. In connection with the closed furnace the patentee employs air chambers, in combination with either hot or cold blast, for the purpose of creating the necessary draught in the furnace, instead of employing a mechanical blast only when such furnaces are used for "roasting" or "torrefying" the ores of iron; and when the furnace is not required to be used for this purpose, but only for the smelting of the ores of iron, the air chambers may be closed by dampers, suitably placed and connected therewith. The fuel employed for the reduction or smelting of the ores of iron, and the manufacture of bar, plate, rod, and sheet-iron, and steel, is peat or vegetable carbon; either peat in its natural state, or compressed peat, or prepared peat, formed by mixing together about equal proportions of peat and small anthracite coal, and compressing the same together into a solid mass by means of mechanical pressure; or a compound of the refuse turf or peat fuel, heretofore considered as waste, dissolved in a pit into a pulp, then moulded into "peats" or blocks. As regards the mode practised for operating with a furnace constructed as above, it is precisely similar to that usually adopted, with the exception, that instead of placing the ores in the furnace in lumps, it is found desirable to crush them, as also the limestone employed as a flux. This operation may be effected by passing them between suitable revolving rollers.

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### IMPROVEMENT IN THE MANUFACTURE OF IRON.

Mr. J. Harrison, of St. Louis, President of the Co. owning the great Iron Mountain of Mo., has made a valuable improvement in charging boxes, for iron furnaces. The box is of the same size as the furnace, cylindrical in form, with a movable bottom. In use, the charge of coal, ore, and limestone, is placed in the box, rolled on a railroad, immediately over the top of the furnace, and then discharged through the movable bottom. In this manner the charge is thoroughly spread out and intermingled; the result, Mr. Harrison tells us, is an increase of between five and ten per cent. in the production of iron. This is an important gain. The old method is to dump in the charge from barrows; but when thus thrown it falls in a heap in the centre of the furnace, where the ingredients cannot so readily melt and combine.

# JOURNAL OF GOLD MINING OPERATIONS.

## CANALS AND DITCHES IN CALIFORNIA.

The Governor of California in his recent message to the Legislature, presents the following statistics of mining operations:

| *Counties.* | *No. of Canals, Ditches, and Branches.* | *No. of Miles.* | *Value.* |
|---|---|---|---|
| Amador | 30 | 355 | $446,000 00 |
| Butte | 16 | 287 | 347,000 00 |
| Calaveras | 17 | 325 | 497,500 00 |
| El Dorado | 20 | 610 | 935,000 00 |
| Humboldt | 60 | 60 | 100,000 00 |
| Klamath | 6 | 130 | 150,000 00 |
| Mariposa | 8 | 150 | 180,000 00 |
| Nevada | 44 | 682 | 1,122,000 00 |
| Plumas | 2 | 65 | 62,000 00 |
| Placer | 29 | 498 | 649,400 00 |
| Sacramento | 4 | 29 | 54,800 00 |
| Shasta | 5 | 89 | 102,000 00 |
| Siskiyou | 1 | 80 | 84,000 00 |
| Sierra | 79 | 310 | 390,000 00 |
| Trinity | 10 | 278 | 228,500 00 |
| Tuolumne | 18 | 235 | 447,500 00 |
| Yuba | 18 | 300 | 560,000 00 |
| Total | 308 | 4,593 | $6,841,700 00 |
| In year 1854 | | 1,164 | 2,294,000 00 |
| Increase in one year, | | 3,429 | $4,047,700 00 |

In addition to the above, one hundred and twelve canals and ditches have been commenced, and will probably be completed within the next year. Amongst them is the Sierra Nevada Mountain Canal—an immense work—ten feet at the bottom, fourteen at the top, and designed with branches, to extend over about one hundred and fifty miles.

## QUARTZ MILLS.

| *Counties.* | *No. of Mills.* | *Tons crushed per Annum.* | *Av. Yield per Ton.* | *Amount realized.* |
|---|---|---|---|---|
| Amador | 13 | 45,000 | $20 00 | $900,000 00 |
| Butte | 2 | 30,000 | 25 00 | 75,000 00 |
| Calaveras | 1 | 20,000 | 20 00 | 40,000 00 |
| El Dorado | 7 | 15,600 | 25 00 | 390,000 00 |
| Mariposa | 4 | 10,100 | 23 00 | 232,300 00 |
| Nevada | 16 | 75,000 | 25 00 | 1,875,000 00 |
| Placer | 2 | 4,200 | 25 00 | 105,000 00 |
| Plumas | 6 | 10,000 | 20 00 | 200,000 00 |
| Shasta | 2 | 2,160 | 30 00 | 64,800 00 |
| Tuolumne | 3 | 3,500 | 25 00 | 87,500 00 |
| Siskiyou | 1 | 2,000 | 25 00 | 50,000 00 |
| Yuba | 2 | 2,500 | 25 00 | 62,500 00 |
| | 59 | 222,060 | | $4,082,100 00 |

Several counties are not included in the above, and from four of the above the returns are incomplete. The erection of fifteen additional mills has been commenced, all of which, it is believed, will be in active operation within the next year.

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## REMARKABLE GEOLOGICAL FORMATION.

The geological formation of that portion of Spanish Hill which has contributed most to its celebrity, as one of the richest gold deposits ever found in California, is one of the most singular and interesting we have ever seen. It consists of a very deep basin, the rim rock protruding out of the ground on nearly every side, so that although one may stand on the bed rock at the top of

the hill, not six feet distant a shaft might be and has been sunk over one hundred feet. In the bottom of this basin are three crevices, the middle one of which, running longitudinally, through the Golden Gate claim, is most singularly formed, presenting the appearance of a quartz lead, of uniform width—about fifteen feet—and dipping towards the east. But, instead of being filled with quartz rock, it is filled with gravel, and massive, round, hard and smooth quartz boulders. The earth taken from this crevice, from the top of the ledge as far down as the shaft was sunk (about ninety feet), paid on an average a little over sixty ounces to every four hundred barrows-full, and the crevice at the east side of, and running parallel to this, being partly on the Golden Gate and partly on the Hook and Ladder claim, paid on an average a trifle over one hundred ounces to the same quantity of earth. The highest taken out of one day's washing, was one hundred ounces. But the most curious piece of work ever done in this, or perhaps in any other country, is now in preparation in the Hook and Ladder claim. The proprietors have been engaged for about four months, day and night, in cutting a tunnel through the bed rock, from a very low point, so as to strike the bottom of the basin. By a recent survey, they have ascertained that they have but a few more feet to run. As soon as they break through the rock and reach dirt, the skilful and enterprising proprietors intend to bring the water immediately over the mouth of their tunnel at a perpendicular height of two hundred feet, where it will be received by a strong hose running up through the tunnel—in which their sluices, and a car to carry off the rock, will be placed. It is intended to literally tear out the very bowels of the hill, so that nothing but a shell will remain, and, doubtless, some day the hill will fall in with a tremendous crash. Spanish Hill is supplied with water by the South Fork canal.

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## JOURNAL OF COPPER MINING OPERATIONS.

### LAKE SUPERIOR REGION.

The accounts from the Lake Superior region have been very meagre during the last two months. Anticipations, however, are very sanguine for the present year.

The *Adventure*, with thirty men only, took out *ten tons* of copper during the month of December. The continued product of this mine, under the circumstances, we regard as a most striking and suggestive fact, and a fact destined to have considerable influence upon the interests of many locations in the Ontonagon district. It will have the effect to attract more and more attention to the workable value of these irregular deposits of copper, of which the Adventure location is a type. It must be recollected that not a pound of stamp work, in which their vein stone is rich, has been included, and that they are necessarily at work under great disadvantages, yet still are probably turning out, say two tons per man per annum of ingot copper.—*Miner.*

### GARDEN CITY MINING CO.

The *Garden City Mining Company* was incorporated under the General Mining Law of the State of Michigan, on the 24th day of October, 1855, with a capital stock of five hundred thousand dollars, twenty thousand shares in the Company, one hundred and twenty thousand dollars paid up by Gordon S. Hubbard, Lorenzo Fletcher, W. W. Mitchell, Aaron Haven, Oren. J. Rose, T. W. Egan, and Augustus H. Hanchett, of the State of Illinois, and Samuel W. Hill, of Michigan, as incorporators.

The lands owned by the company are comprised in two mining tracts, in the Keweenaw Point District, Lake Superior, Michigan. The "Killiher Mine," the most easterly, is embraced in the east half of the south-west quarter and

the south-west quarter of the south-east quarter of section two, and the north half of section eleven in township fifty-eight north, of range thirty west, and contains four hundred and fifty acres of land.

"The Hill Mine," situated eight miles west of the "Kelliher," is contained in the south-west quarter of section twenty, and the north half and south-west quarter of the north-west quarter of section twenty-nine in township fifty-eight north, of range thirty-one west, embracing an area of two hundred and twenty acres.

The territory occupied by these tracts jointly, embraces all the metalliferous bands of rock from the crystalline trap, at the summit of the north range, to the alternative strata of sandstone and trap rock, on the north, near the shore of Lake Superior, and have been mined in the Phœnix, Humboldt, Copper Falls, Native Copper, and Clark mines, with success commensurate with the work done at these mines respectively.

The lands of the Company are covered with different varieties of timber suitable for building and mine purposes, supported by a soil that will readily grow the grasses, roots, and all kinds of broad-cast grain crops (wheat excepted) needed in the mining district, with proper cultivation. They are also well supplied with water sufficient for all purposes required in stamping and dressing copper. On the "Hill Mine" a stream of sufficient volume and durability crosses the tract near its northern boundary, to furnish a hydraulic motive power for running eight head of stamps, at a trifling cost to the company.

On the "Kelliher Mine" three veins have been discovered, each one mile in extent. The largest of these veins is, as appears at different points where opened, of an average width of four feet, and well supplied with stamp, barrel, and small mass copper. Little more has been done on this mine than to demonstrate the existence of the veins, their extent, direction, and width, together with the character of the matrix of the lodes. Its proximity to Agate Harbor is two and a half miles, with a feasible route intervening, over which a road can be constructed at a trifling expense, and to which port it is thought advisable to open a thoroughfare for the benefit of the mine at some future period.

The "Hill Mine" is bounded on the west by the Phœnix Copper Company, and one mile east of the territory of the Cliff Mine, and in the same geological position on the northern escarpment of the trapean range. Across the territory of this mine six veins are known to exist, each of one mile in length, one of which has been sufficiently examined to justify the Company in commencing mine operations thereon, with strong encouragement of making it a dividend paying mine. This vein has been opened at different points within extremes for two miles in extent, exhibiting copper at every point, in different degrees of per centage. The Phœnix Company have opened it on the north in an adit gallery of near three hundred feet in length, out of which masses of pure copper have been taken, from inferior sizes to that of 2300 lbs.; the largest of which was discovered within sixty rods of the northern boundary of the lands of this Company. The Eagle River Company are working on the same vein within one-fourth of a mile of the south boundary of this mine, with every promise of success, under the able superintendence of Charles Whittlesey, Esq.

The original proprietors have measurably relieved present venturers in this mine of the risk usually incurred on investments in unexplored mineral territory, in the expenditure, on private account, of a sum necessary to prove the productiveness of this vein on the lands of the Company. An adit gallery opening about six hundred feet south of the northern boundary of this mine, has been driven seventy feet in extent through the scoriaceous or volcanic ash belt, containing a stamp work of unusual richness on the upper side of the stratum. South of the mouth of this gallery a few hundred feet, a shaft has been sunk on the same vein to the depth of twenty feet in the gray *compact* trap, disclosing a vein two feet wide, well charged with small

masses, barrel and stamp copper. The scoriaceous belt is near one hundred feet thick, and has been opened in a line with the strata on different mines for twelve miles in extent, and at every point presenting a uniformity in mineral resources.

A system of economy, suitable to adopt, forbids the outlay of the means necessary in opening the Kelliher Mine, although it possesses one of the largest and strongest veins of the country, until the other, that requires much less expense, is brought to a dividend-paying condition. It may be advisable, during the coming season, to extend the explorations already commenced on that tract, sufficiently far to enable the Company to effect permanent mine plans for future operations, when it may be deemed advisable to prosecute them.

From the amount of exploring and mine work already effected on the Hill Mine, the directors deem it advisable to commence mining operations thereon as soon as practicable in the ensuing spring. The fact also that one of the veins on this mine has been wrought at points two miles asunder with favorable results, together with the important advantage of proximity to the port of Eagle River, with a good road intervening, has operated largely in inducing this determination. In the opinion of the directors, all the means of the company devoted to mining purposes, should be appropriated to the sole object of bringing this mine to a dividend paying condition at as early a date as practicable, avoiding, as far as possible, any unnecessary expenses for surface improvements. Early efforts will be made to secure the lease of suitable tenements for the employees of the mine, in its vicinity, thus obviating the expenses incident to building, for the first year at least. The lands already cleared, and suitable for tillage, will be seasonably prepared for appropriate crops, and the services of a suitable superintendent secured to take charge of and direct the operations of the Company at the mine.

That the mining region of Lake Superior is rich in resources, the success of the Cliff, Minnesota, North America, Rockland, Isle Royale, North Western, and Central mines clearly prove with a few years' experience under many and great commercial disadvantages. The Cliff Mine, although having been wrought but a few years, is enabled to declare for the current year a semi-annual dividend of eight dollars per share, shares originally costing only eighteen dollars each, the present market value of which is one hundred and forty dollars, with a contingent fund from its earnings of two hundred thousand dollars. The Central Mine, from its first year's operations, netted twenty-four thousand six hundred dollars on an investment of eight thousand four hundred dollars, having in reserve over net profits all the provisions, mine supplies, and other assets necessary for six months' operations. That favorable results in mining are to be achieved without economy and judicious management in every department of the enterprise, the successes of the country most clearly disprove.

No doubt exists that the Garden City Company are in possession of mineral territory of great value; at the same time it is a fact of no less consideration that economy and attention are as requisite in the profitable development of its resources as is required in the enterprise of trade, manufacture or commerce.

The Directors would state, in conclusion, that the prospects of both of the mines belonging to the Company fully justify them in the determination to prosecute vigorously and with cautious persistence the work necessary to the development of each, consecutively. It is impossible to state, with any degree of accuracy, at what time each, or either of them, may become remunerative, yet sufficient is known to render it certain; the prospects, so far as the work has progressed, are equal to the best among the mines of the country.

*The Minesota Mine.*—The results of the operations of this great mine for the year 1855 are in the highest degree satisfactory. The product of copper is as follows:—

| | |
|---|---|
| January, | 147,931 lbs. |
| February, | 202,854 " |
| March, | 230,098 " |
| April, | 227,873 " |
| May, | 225,889 " |
| June, | 224,762 " |
| July, | 279,078 " |
| August, | 260,746 " |
| September, | 288,297 " |
| October, | 269,268 " |
| November, | 231,225 " |
| December, | 280,402 " |
| Total, | 2,868,422 " |

Tons, 1,434 and 422 lbs.

There were shipped from the Minnesota, Rockland, Flintsteel and Peninsular mines, all of which may be said to be under the management of the officers of the Minnesota, 2,555,021 lbs. of copper. 168 tons were left on the docks at the close of navigation, the inclemency of the weather preventing their shipment from this port.

Their underground workings for the year are about as follows:

| | |
|---|---|
| Amount drifted, | 3,000 fathoms. |
| Sinking, | 418 " |
| Stoping, | 2,602 " |

The ground has yielded about 900 pounds of copper per fathom, and they have raised about *eight tons* for every man employed under ground. The copper raised is of very high purity, and will, we believe, produce about 75 per cent. of ingot copper, thus making six tons raised for every man employed under ground.

The mine is now pretty well opened.

| | |
|---|---|
| Total length of all drifts, | 11,000 feet. |
| " depth " shafts, | 2,500 " |
| Longest Level on main vein, | 1,660 " |
| Deepest Shaft on main vein, | 447 " |
| Longest Level on South Lode, | 1,250 " |
| Deepest Shaft, | 270 " |
| Extreme length of openings in both veins on one level, about | 2,300 " |

They are now working 220 miners. The whole number of men and boys employed about the mine is 470, and the total population of the mine is 600 souls.

The present year's product will undoubtedly be very large, though that of January is greater than can be expected of each of the succeeding months. The masses in sight are about equal to those seen at any previous time, and they are just taking down ground which has the appearance of being exceedingly rich. The great mass in the 10 level, of which we have frequently spoken, still holds its size, although they have been taking 50 or 60 tons per month from it. Between shafts 8 and 5, in the same level, they have commenced stripping another large mass, already uncovered, 40 feet long and 20 feet high. As near as can be estimated, it is about 18 inches thick. The openings in the 60 level, below the junction of the two veins, show a lode of great promise.

The hoisting engine on the south lode is now in operation, though it cannot at present be used very effectively for want of feed water. In the fall we anticipated great loss to the company from the fact that parts of this engine were left at Copper Harbor. But these parts have been supplied by borrowing from other mines in the district. A shaft, a pump, pillow blocks, pipe, bolts, &c., have been picked up here and there, until the machine has been made complete, and ready for duty. It will enable them to add very considerably to their production of copper during the winter.

The following list of masses larger than 4,000 pounds which were raised and weighed during the month of January, will show about the sizes to which they reduce their large copper:

| Pounds. | Pounds. | Pounds. | Pounds. |
|---|---|---|---|
| 4,586 | 4,881 | 5,269 | 4,800 |
| 5,552 | 4,400 | 4,570 | 4,890 |
| 6,648 | 5,061 | 4,400 | 4,042 |
| 6,659 | 4,500 | 4,500 | 5,000 |
| 4,052 | 5,681 | 4,925 | |
| 5,428 | 5,578 | 4,415 | |

The *Rockland Mine.*—This mine raised during the year 1855, 122 tons of copper. Their operations for some months past have been principally directed to opening the mine, and cross-cutting for the Minnesota south lode. When we visited it, on the 8th inst., the character of the ground was changing, and they expected soon to cut that vein. They had driven 257 feet south from the Rockland vein.

Capt. Jennings spoke very highly of the ground they were opening in the mine.

Their stamp mill and railroad had been in operation for some days—both performing beautifully. The arrangements of the road are very convenient, and the track is finely laid. The vein stone is run out of the adit on a tram, and dumped at once into the kiln. After being burned, it is thrown into cars which are brought up to the mouth of the kiln, and taken something less than half a mile to the stamp mill, when it is dumped into the hoppers—thus requiring no handling except at the kiln. The road has a rolling grade, so that the cars require only to be drawn back. A horse will take down 40 tons per day in this way, or rather, will return the cars which take down the amount.

Eight head of stamps were in operation, and they were putting up four more. They were also fitting up the washing tables. The operation of the machinery, as far as it is fitted up, gives great satisfaction.

The *Norwich* are driving a fine adit or gallery 800 feet to the west of shaft No. 2. It is probably the largest and most commodious work of the kind on the lake, being full seven feet high and eight feet wide, and is intended to admit the hoisting and draining apparatus which will be necessary when they sink the mine deeper. It is large enough to do this without interfering with the regular business of the tramway, which will run through it. It is already driven 150 feet, and will probably cut the vein in 100 feet more.

The third and fifth level of this mine look remarkably rich. The fifth is driven but very little, but they have a fine mass of several tons. The second level also shows important masses. On the whole, the mine is looking remarkably well.

They are working 26 miners in opening ground, who will place the mine in a fine condition for the production of copper, as soon as they can obtain supplies for working a large force. They have some 40 tons of copper on hand.

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## QUARRIES AND CLAYS.

### SHELL MARL IN MISSISSIPPI.*

According to the above analysis 100 lbs. of the marl contain 58.460 parts of soluble matter: this soluble matter consists of 8 lbs. of oxide of iron and alumina; nearly 33 lbs. of carbonate of lime; 3.352 of phosphate of lime; 3.684 lbs. of sulphate of lime; 9.10 of a lb. of chloride of magnesium; 7.840 or very nearly 8 lbs. of alkalies mostly potash, and a small quantity of ammonia. It is, therefore, very evident that this marl must be a most excellent manure, especially for light soils, of which the northern, middle, and southern parts of our State abound. It contributes to the value and importance of the deposit of marl, that it is not only situated in a region where it is eminently ap-

* Continued from vol. V., p. 356.

plicable, but that it is immediately on a navigable river, and within a mile or two only from the Mobile and Ohio Railroad; it can, therefore, easily be transported to many counties of this State and of Alabama.

Of what importance good marl is for an agricultural State, is shown in the example of the States of North Carolina, Virginia, and New Jersey; a large part of the land of those States is actually renewed by the effect of marl, and I doubt whether either of those States can produce such a superior marl as that of the deposit of Clarke County, which is, indeed, not much inferior to guano, and for some soils of our State even better.

The great importance of this deposit of marl for our State has induced me to hasten the publication of its discovery and quality, and I now invite the agricultural public to avail themselves as soon as possible of this fine manure, and to inform the undersigned of its effect.

The tertiary lime-formation in Clarke and Wayne Counties, does not only afford this fine marl, but, as I have already remarked, the upper part of it, the hard carbonate of lime or limestone yields, in some places, a most excellent material for burning quick-lime. Such a locality I found in Wayne County on Round Hill, near Limestone creek, immediately on the Mobile and Ohio Railroad, and on the plantation of Dr. E. A. Miller. There are three different kinds of limestone to be found, viz: a very hard, white limestone, hard enough for building; a soft limestone of a yellowish color, and rather brittle, and lastly, a shell limestone nearly entirely formed of tertiary shells, especially of the genus pecten, and still more mixed with oxide of iron, and, therefore, very yellow. I collected specimens of all those three different kinds, and an analysis of them has given the following results:—

No. 1. The hard limestone consists in one 100 parts of:

| | |
|---|---|
| 1. Insoluble Silica and Alumina | 6.300 per cent. |
| 2. Oxide of Iron and soluble Alumina | 7.200 |
| 3. Carbonate of Lime | 86.500 |

No. 2. The soft limestone contains in 100 parts:

| | |
|---|---|
| 1. Insoluble Silica and Alumina | 15.050 |
| 2. Iron and soluble Alumina | 5.350 |
| 3. Carbonate of Lime | 79.500 |

No. 3. The shell limestone contains:

| | |
|---|---|
| 1. Insoluble Silica and Alumina | 9.200 |
| 2. Oxide of Iron and soluble Alumina | 6.650 |
| 3. Carbonate of Lime | 84.150 |

Carbonate of lime contains, besides the lime, carbonic acid gas, at the rate of 43.708 per cent. No. 1. contains, therefore, in 100 lbs. only 48.693 lbs. of pure quicklime; No. 2. only 44.809 lbs., and No. 3. only 47.370 lbs. If well burnt, 100 lbs. of No. 1. will, nevertheless, weigh 62.193 lbs., but 13.500 lbs. are impurities, and only 48.693 lbs. are pure lime; 100 lbs. of No. 2. well burnt will yield 65.304 lbs. but 44.809 lbs. are only pure lime and 20.495 lbs. are impurities mixed with it. 100 lbs. of No. 3. well burnt, will yield 63.220 lbs., but 47.370 lbs. are of pure lime, and 15.850 lbs. are impurities. It is, therefore, evident, No. 1. the hard limestone, is the best for making quick-lime; it not only yields most, but gives also the purest lime. If we have such fine material for manufacturing quick-lime in our own State, why do we not use it? why do we purchase our lime from other States, especially from the hostile North, if we can make it ourselves fully as good, and much cheaper than we buy it?—*Columbus Sent., Miss.*

THE

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## Mines, Mining Operations, Metallurgy, &c., &c.

VOL. VI.—APRIL, 1856.—No. IV.

### ART I.—PROCESSES FOR THE DISTILLATION AND PURIFICATION OF THE PRODUCTS OF COAL. By MANSFIELD. No. 2.

[Continued from page 201, Vol. VI.]

I NOW proceed to state how these substances may be obtained, first remarking that I shall describe other properties of some of these spirituous substances and oils, when treating of the preparation of each.

And first I will describe the manufacture of Alliole.

This spirituous substance may be separated either from coal, or from coal-tar, or from the most volatile part of the oil distilled from coal-tar. I obtain this spirituous substance by reserving the first portion of oil which passes over on distilling the tar, or the most volatile oil distilled from the tar in the ordinary manner; and it is convenient to separate the first portion equal to one eighth of the light oil or naphtha, which is expected from the retort; but the smaller the quantity set aside at first, the purer, more volatile will the spirituous substance be. It is convenient sometimes to continue to receive the distillate, so long as a sample taken from it will yield a flame entirely white on igniting a current of air passed through it, as above described, in respect to what I have called a *test bottle;* and this applies equally to the rectification by steam, or by simple distillation with or without water. By repeating this process with the portion set aside at first, and again reserving the first portion, a more volatile spirit may be obtained, and this will be more volatile the oftener the process is repeated. The residue which remains each time may be added to the common naphtha; and in so treating the oil or naphtha, I prefer to distil the oil or naphtha in a retort by heat applied without admitting steam or water into the oil or naphtha, and to use a thermometer inserted in the retort, or so connected with it as to indicate the temperature within the retort. And I prefer to set aside separately those portions that distil over while the temperature of the naphtha is rising through successive intervals of temperature; by this means I separate the naphtha into several oils and spiritu-

ous substances differing in respect to their boiling temperatures; and by repeating this process several times on the first products, I obtain a considerable quantity of a very volatile spirituous substance, whose boiling temperature is between 60° and 80°, which does not solidify by the application of cold about 20° (that is 20° below zero). This process may be considered tedious, but it yields a very volatile spirituous substance as a result, and a similar process is applicable to obtaining in a more or less pure state the other spirituous substances and oils before mentioned. Or I apply to the coal-tar or crude naphtha any of the usual processes which are well known, and which are applied to the distillation and rectification of spirit of wines, the residue, in the case of spirit of wine, being a watery fluid, and in this case tar or oil.

As what relates to rectification applies equally to benzule as to the alliole in coal-naphtha, and the benzule is the more important and more abundant product, I shall now pass on to the methods of obtaining benzule, observing that the same methods apply to alliole, except that when alliole is required separately, the first and most volatile portions, viz., such as distil over below, or only a little above 80°, must be reserved alone, while for benzule the temperature is allowed to rise higher before charging the receiver.

The same methods apply to obtaining the volatile spirituous substances from other tarry and bituminous and hydro-carbonaceous matters, such as wood-tar, petroleum, mineral naphtha, oils distilled from bituminous schist, from caoutchouc, and other such matters; and it may always be ascertained by a single experiment, with a small retort and thermometer, as above mentioned, whether any sample of such matters contains sufficient of spirituous substances to render it worth distilling, it being observed whether a large or small fraction of the substance distils over at a temperature below 100°, except that when the application is made to substances other than coal-tar or coal-naphtha, what is said of alliole and benzule must be considered to apply to spirituous substances of nearly similar volatility, but not necessarily corresponding in other properties to alliole and benzule.

The more perfect the system of rectification, the more free will the spirituous substance be from oils having less volatility; and for the preparation of benzule such mode or modes of rectification are preferable as will allow as much as possible of a very volatile spirit which boils when pure at about 80° to pass over in vapor, and will keep back the vapors of the less volatile oils. The process of rectification which I recommend, is one in which the tar, crude-light oil, or crude-naphtha (but I prefer to use the crude-naphtha or light oil of tar) is placed in a retort, which is heated either by the direct application of fire, or by steam carried through it either in closed pipes, or by a pipe opening into the bottom of the retort; the vapors from the retort are conducted

through a head in which a partial condensation of the less volatile vapors takes place, so that these are returned in the liquid state, either to the retort or to a separate receiver, and the most volatile vapors are allowed to pass on to a condenser, which is kept as cold as possible, and are then received separately. And I recommend that the first condenser or head consists of a room or chamber, with a lower opening, by which all condensed oil may flow back freely into the retort or other vessel, with an upper opening or pipe to conduct the uncondensed vapors to the next condenser; and I recommend that, in the first distillation, this upper condenser should be surrounded with water, which should not be changed, but be allowed to rise in temperature as the distillation proceeds till it boils; or there may be two or more such vessels, in each of which a partial condensation may take place so as to rectify the spirituous matters by one distillation, each being connected, if required, with a separate special receiver for the less volatile part therein condensed; and the apparatus may be so arranged that the vapors from the retort or preceding condenser, either may or may not pass through the fluid in each succeeding receiver; and in case more than one such partial condenser is used, I recommend that the temperature of that nearest the retort be allowed to rise till the water surrounding it boils, and the temperature of the last, or that farthest from the retort, be kept at or below 50° or 60°, if alliole be required, or 80° or 85°, if benzule be required; or that the temperature in the last partial condenser be kept below 60°, till vapors have ceased to escape from it to the final condenser, which will be known by the cessation of distillation at the final receiver; and then the fluid in the final receiver being set aside as alliole, the temperature in the last partial condenser may be allowed to rise again till it reaches 80° or 85°, and the distillate received as benzule so long as it continues to run. I recommend that the size of the head or partial condenser, if only one be used, be of or about the same proportion to the size of the retort, as the condensing apparatus of an ordinary still bears to the still itself, but the water surrounding the head may be in a much smaller quantity than is necessary in such part of an ordinary still; if more than one partial condenser be used, they may be proportionably smaller. And when I use the term "head," I would have it understood that I use it for brevity to express a partial condenser placed over a retort, in which an inner condensing chamber is surrounded with water, or sometimes with oil contained in an outer vessel.

If this proportion be observed, it will usually be found that the distillation will proceed regularly while the temperature of the water in the head gradually rises, and that distillation will cease when the water in the head begins to boil. Distillation may then be continued either by drawing off the water from the head, or by opening another neck attached to the retort, through which

the remaining naphtha may come over, which will not differ much from ordinary naphtha in any of its usually-recognized properties. I then repeat this process any number of times, according to the degree of purity and volatility of the spirituous substance required; or, as before stated, by means of successive partial condensers I obtain the requisite purity by one operation, and I regulate the temperature of the water surrounding the head by the volatility of the spirit required. The cooler the head be kept the more volatile and the less in quantity will be the spirit obtained. And I have two methods of ascertaining the volatility of the spirit which is distilled over at any time; first, by a thermometer which is either inserted in the retort, through its side or cover, through a cork or stuffing-box, or is kept loosely in a closed tube which projects from the side of the retort into the interior, which tube should be kept corked, to prevent access of cold air to the thermometer (and in this case the thermometer will usually show a temperature two or three degrees lower than the true heat of boiling fluid), or the bulb of the thermometer is placed in a small chamber connected with the upper part of the retort by a short neck, in which is a cork, by turning which vapor may be allowed access to the thermometer, or the thermometer may be attached, if successive partial condensers and receivers be used, in the same manner to the last partial receiver, through which the vapor passes before entering the last head or partial condenser. And here I may remark, that the more nearly the temperature of the retort on the second or any subsequent rectification, or if the successive rectifications be conducted by one operation, the temperature of the last chamber or receiver through which the vapor passes before passing through the last partial condenser, approximates to 80°, while the contents of the retort are in active ebullition, the more nearly will the fluid distilling at the same time approach to the nature of benzule, and the more easily will such spirit be purified by refrigeration, according to the method to be hereafter described. And I recommend that when benzule be required for purification by freezing, such temperature be not allowed to pass 90° before the receiver is changed. And as the temperature rises in the retort the distillate will be less and less volatile. And the other method in which I ascertain the volatility of the spirit is by the flame yielded by the test bottle, with a current of air, as before described. If a portion of the first, and therefore most volatile, distilled from the naphtha be placed in such a bottle, and common air be blown through the tube which reaches below the level of the fluid, as may be done conveniently from the mouth, and if a lighted match be at the same time applied to the mouth of the other tube, the air escaping will have taken up so much of the vapor of the spirit, that it will burn with a white flame. If samples be taken as they come from the still at intervals, and placed in such a test-bottle, it will be observed that

the air will still burn with a white flame; after many such samples have been tried, as the temperature in the retort rises, however, it will be observed that the test-bottle shows a diminution of the whiteness in the flame, which becomes more and more blue from below upwards, till only the tip of the flame will be white; next the whiteness will disappear, and the flame will become entirely blue. And if the distillation be conducted in a still which permits the whole of the naphtha to pass over, it will be observed that when the operation has been continued to a certain point, the test-bottle will no longer yield any flame. I find it convenient sometimes to regulate the change of the receiver by the observation of the flame, according to the volatility of the fluid required. It will be found that all that comes over on the second rectification of the spirituous matter below 90° will yield a good white flame; and about 100° about one half or more of the flame will be white. And here I will further state the properties of the distillates obtained as the temperature advances, which it is the object of my invention to separate from each other and to purify. The first portion of the distillate will generally be an extremely volatile spirituous substance, which, when purified, is of a peculiar alliaceous smell, somewhat resembling that of bi-sulphuret of carbon; it boils when pure at about 65° or 70°, and is changed by mixture with concentrated sulphuric acid, which forms a compound with it. It does not solidify at 20° below zero. It will usually be obtained mixed with a certain quantity of the spirituous substance which next follows in the scale of boiling points. To obtain it moderately free from which, it is convenient to receive for alliole all that comes over before the boiling temperature in the retort is 90° on the first rectification, and 80° on the second; or if distilled through a condensing head before the temperature of the head has passed 60°, but by extending the distillation from this spirituous substance a little further, its volatility is but slightly diminished, and I obtain a mixture of it in any proportion with the spirituous substances of higher boiling points. If it be required to obtain alliole from the naphtha, the naphtha should not have been treated with concentrated acids before distillation, since this substance is, for the most part, changed by such substances. Immediately following alliole in the scale of boiling points is benzule, which, when pure, boils at 80°, and becomes solid at zero; it exists in the naphtha, in far larger quantities than the preceding oil, amounting in some cases to one eighth of the light oil obtained from the tar; it has a smell somewhat resembling almonds when pure, and is extremely volatile. It is not destroyed by agitation with sulphuric acid (by which I mean oil of vitriol), and it is convertible into an oil resembling oil of bitter almonds by nitric acid. To obtain this oil in a state of moderate purity is the chief object of the rectification to which I subject the naphtha; I obtain it pure by a process hereafter to be described.

In the state of moderate purity in which it is obtained by the processes of rectification above described, it is of the same volatility as alcohol, which it resembles in some of its properties, but it is more nearly allied to ether, as a substitute for which it is generally applicable. At common temperatures it yields so much of its vapor to a stream of air passed in contact with it, that the air will continue to burn with a white flame till the whole of the fluid is volatilized, and this will distinguish it as well as alliole from any naphtha, however highly rectified, which has hitherto been manufactured from coal-tar; for though some of the naphtha of commerce is so volatile as to yield a white flame with air passed through it, yet, before the whole of any such naphtha has volatilized, a fluid will remain, which will either yield no vapor to the air so passed through it, or only so much as to yield a blue flame.

To be Continued.

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ART. II.—GEOLOGICAL SURVEY OF MISSOURI. REPORTS I. AND II.

IT has been well said, that if the American mind was as practical as it is theoretical and energetic, it would subdue the world by the mere simple elements of its æsthetico dynamics. Whether this good time of æsthetico dynamic annexation is at hand or not we may not say; but if the very practical effort of Missouri to utilize her natural resources is any expression of the signs of the times, then something has been done towards, and in favor of, this moral and mental subjugation. To utilize the profusion of the elements of industrial riches which a kind Providence has sown broadcast over our land, is becoming more the spirit of the age.

We think we may safely assume that the leading thought—the key-note—of our Magazine has been to utilize and make practical the *mining-facts* and mineral resources of our country, to make our monthly, in fact, a handbook of inductive science for directing attention to the economics of our buried treasures.

Impressed with this thought, we hail with peculiar pleasure the report, the title of which caps our article. We see in this work a practical effort of one of the younger sisters of our galaxy of States, not yet two score years of age, to accomplish, and in fact, actually and effectually accomplishing, that which some of her sister States, older by scores of years, have not, until within a comparatively recent period, accomplished. These Geological State Surveys, already executed and in progress, will do more to develope the resources, increase the strength, and make moral

and physical *materiel* for prosperous communities, than all other causes, because the riches of the earth enlarged by labor are the foundation stones of agriculture, manufactures, and commerce. The first attempts at State Surveys were expensive, and too formal—not one bit too scientific—yet too little practical for the public apprehension. The public mind and eye were not accustomed to the thought of such a survey—cui bono? was exclaimed—too much book learning about—the matter was *too far off* for the farmer, mechanic, and every-day-man. The earlier surveys were expensive on account of the want of that artistic skill which in this day is so beautifully exemplified in the designs, sketches, and illustrations of the recent surveys.

Experience and science will improve these matters, and, as Prof. Swallow well remarks, science is the very essence of all experience. Missouri, although the last in the field, has profited by the experience of other States, and has thus given to us a work scientific and practical—a reference book for the savan, a hand-book for the every-day-man.

The volume embraces the first and second "*Annual Reports of the Geological Survey of Missouri, by G. C. Swallow*"—with the address of the "*Geological Rooms, State University, Columbia, Mo.*" Dec. 1 1855," published by James Lusk, Public Printer, Jefferson City. We give title-page in full, because (with the illustrations bearing the imprimatur of Missouri artists) it gives another proof of the progress westward of the arts of life. The whole work is Western, in mind and body, and alike creditable to the noble State which fosters and the talent employed in the enrichment of the people of the State. And why should it not be so?—the capacities and capabilities of the American Western mind are, like the natural and indigenous formations and developments, all on a large scale.

It is often the case in such surveys, that the individuals composing the corps of operators, and whose personal devotion and scientific skill give to the surveys a large portion of their practical value, are passed over by the public notice. In the Survey of Missouri, Prof. Swallow has handsomely acknowledged the merits of his collaborators, and we take pleasure in according to them their full measure of praise for a high order of attainment in their profession.

To A. Litton, M. D., of St. Louis, we owe the interesting facts relating to the composition and chemical equivalents of soil, and other substances connected with the economics of the State. B. F. Shumard, M.D., of Louisville, as Palæntologist and Assistant Geologist, and formerly on the U. S. Survey of Oregon, has contributed largely to the interest and value of the work in his peculiar department. R. B. Price, Esq., of Brunswick, has shown his skill as a draughtsman and artist in maps, sketches, and illustrations throughout the work, that, for the ground they cover, are of a

style and character quite equal to any State Reports that have yet fallen under our notice.

Mr. F. Hawn of the Hannibal and St. Joseph's Rail Road, has contributed his report of his explorations which were highly successful in developing the agricultural and mineral wealth of his section. Mr. F. B. Meek of Owensboro, Kentucky, another Assistant Geologist, presents a valuable report on the economic Geology of his section, and a catalogue of fossils.

As before stated, all the talent and materiel of the Survey were made up of native Western stock.

The literary character of the work is good, although we think there are, here and there, a few sharp corners of thought and consequent angularity of expression (with a dip decidedly quaqua-versal), more suited to the *locality* of an indignation meeting than the *depository* of scientific inductions. The Professor has certainly let loose a *dibacle* upon all tyros, and safely embedded them beneath a quaternary of no uncertain depth.

Mr. Swallow has not only understood himself (a sort of self-knowledge rarely acquired nowadays), but he has evidently made himself understood by his corps. The reports of his assistants, made from distant standpoints, express unity in diversity—the leading thought of the principal mind.

We like his order of business exceedingly, viz.: 1st. To make out an outline of the Geology of the whole State. 2d. A general view of the mineral wealth of the mining districts. 3d. An exposition of the agricultural and manufacturing resources of the State. 4th. Reports in detail upon the counties. In this order five counties have been finished, eight advanced towards completion, and some fifty others commenced. Many difficulties were encountered (incidental to the pursuit of knowledge), such as the short time allowed for the exploration, and natural causes. The consolidated strata were often buried very deep beneath quaternary deposits of loose texture which have filled up former denudations, and left a talus to conceal the erosions upon the underlying rocks. These, together with the presence of many abnormal local deposits, the remarkable identity of analogous, and lithargical characters, and rarity of fossils in the four magnesian and three sandstone formations, forced the explorers to mere stratigraphical deductions.

One of the results of this Survey will be, a complete geographical and topographical map of each county, showing the bottoms and uplands, prairies and timber, soils and geological formations, with stratigraphical sections,—furnaces, mineral deposits, and mineral springs. These delineations, together with a *description* of what formations contain ores, coal, marble, &c., the quality and quantity of each, the value and facilities for working them; the varieties of soil and area of each variety, the modes of culture adapted to each; the quantity and quality of timber, and

mode of manufacturing it, and amount of water power in the streams,—all these constitute the very elements of the State's prosperity, and a body of practical and tangible facts of vast importance.

These descriptions are presented in language sufficiently plain for the commonest mind that has had a common-school education, without that foolish abnegation of those useful and distinctive terms so necessary in scientific terminology.

The nomenclature adopted by the Professor has been that of the New York Geologists for the well characterized and older palæozoic rocks, with a few provisional names for partially explored and undetermined developments. Prof. Swallow says in his report: "It is both absurd and impossible to write a Geological Report without scientific terms. No Geologist can do it, and, were it possible, no one could understand it. Every science and profession has its peculiar terms; the sailors' '*buoy*,' the printer's '*pi*,' the carpenter's '*rabbet*,' the saddler's '*tree*;' the '*mandul*' of the smith, the warrior's '*mangonel*;' the merchant's '*bocasine*;' and the politician's '*Hards*' and '*Softs*,' are as peculiar and limited as Pentremite and Muschelkalk. But there is a more serious objection to common names; they must of necessity be more or less ambiguous, as every such name has at least one common meaning, and if used in science it would have another. Take, for example, '*Black Jack*;' as a common name it means a '*Leathern Cup*;' scientifically applied to Zoology it means a '*Black Negro*;' in Botany a '*Scrub Oak*;' and in mineralogy '*Sulphuret of Zinc*.' Take the following sentence: 'We saw two crystalline masses of sulphuret of zinc lying at the Duke of Sutherland's front entrance.' Now 'crystalline masses' and 'sulphuret of zinc' are scientific terms which have only one meaning, so that we know precisely *what* was seen at the Duke's front entrance; but if the learned author had used two very common names instead of these scientific terms, the sentence would read thus: 'We saw two Dornicks of Black Jack lying at the Duke's front entrance,' and no one could have told what did lie there, as Dornicks and Black Jack are both ambiguous and common terms."

The exploration has already shown the State to be immensely rich in natural resources; her coal and iron ore to be more precious than sands of gold or veins of silver.

Too nice criticism in a work of this kind would be hypercriticism, where we are looking for solid facts for the materials to form our own judgments. We find the work in this respect such as it ought to be. The subsequent reports will be looked for with much interest.

ART. III.—THE IRON MANUFACTURE OF GREAT BRITAIN—THEORETICALLY AND PRACTICALLY CONSIDERED. By WM. TRURAN, C. E. No. 5.

[Continued from page 287.—Vol. VI.]

## PRACTICAL SMELTING.

THE process of converting the ore into metallic iron is the most important operation of an iron works. As a necessary consequence, therefore, the working of the blast furnace requires the greatest attention from the iron-master and attendant workmen. Any irregularity in its operations, if allowed to continue unaltered for a lengthy period, may endanger its safety. Very trifling circumstances, often, will produce the most extraordinary changes in the operations within the furnace. After carefully apportioning the burden and materials to the production of gray pig iron, we probably obtain an inferior description of iron several times in a week. On other occasions, without any apparent cause, the metal will be white and of a coarse quality for a lengthy period. Irregularities equally great occur, in the make or quantity of metal produced weekly. Indeed, we may remark that there are no operations in iron works attended with such uncertainty in their results as those connected with the blast furnace.

When we consider that the quality of the future bar iron is dependent on that of the pig from which it is to be manufactured, and that every irregularity in the working, and every stoppage of the furnace, from whatever cause, is attended with expense and loss, we may well infer that the healthy working of the furnace is a primary consideration with the iron-master.

In previous sections we have described the various iron-making materials used in this country, and the preliminary operations to which they are subjected before entering the blast furnace. We will here examine the operations connected with the filling and working of blast furnaces, and the extraction of iron of different qualities in the large way.

## FILLING.

The ore having been calcined is filled into the furnace by barrows, or, as is still the practice at several works, by iron baskets. Between each barrowful of ore, the requisite quantities of fuel and flux are also wheeled into the furnace. The weight of calcined ore which a definite quantity of the fuel will smelt is understood as the "Burden." The burden varies at furnaces in the same works, being dependent on the joint qualities of the ore, fuel, and flux, the volume of blast, state of furnace, and quality of crude iron desired. A charge consists of the weight of calcined ore, and proportionate weights of fuel and flux. By the number

of charges which the furnace receives in a certain time, generally 12 hours, is the rate of smelting reckoned, and the probable make of iron estimated.

The general rule is to fill with barrows, loaded according to the materials to be filled, and local custom, with from 4 to 16 cwts. in each. This mode is attended with the least consumption of labor, but we doubt its being the most advantageous in point of yield and quality. When the respective materials are projected into the furnace in quantities up to 15 and 16 cwt. we cannot insure that commingling which is produced when they are filled in lesser quantities. On the continent of Europe it is usual to mix the ores and flux before filling; the higher value of labor is generally given as a reason for not pursuing a similar course in this country. It is, however, very probable that a similar procedure might be adopted with considerable advantage. The continental iron-master smelting with charcoal, produces a ton of iron with less than one half the quantity of carbon consumed in this country. Now, as a portion of this superior economy is unquestionably owing to the more perfect admixture of the materials, the additional labor demanded would be more than compensated by the smaller consumption of carbon, and superior produce of the furnaces.

The present mode of filling is productive of much irregularity in the working of the furnace. To avoid some trifling inconvenience, or from ignorance of the injurious effects produced, we have observed fillers charge several barrows of ore through one side of the tunnel head without the usual complement of fuel, which has been charged at the opposite side. In such cases, the ore descends the furnace, but arriving at the tuyeres with an inferior portion of fuel, the temperature attained being insufficient for the perfect reduction and separation of the metal, the adjacent tuyere is partially, if not entirely lost, by the adhesion of the semi-fused materials. The injurious effects of such filling are most apparent with a cold blast. The immense volume of cold air projected on a mass of materials, void of the necessary carbon for combustion, causes a rapid cooling, and not unfrequently, the loss of the tuyere.

The weight of ore and flux, to fuel, having been ascertained by analysis or experiment, it is of importance that the same be maintained by the workmen engaged in filling. For their guidance one or more weighing machines are placed in the barrow-road to the tunnel-head, having suitable weights beyond the control of the workmen. By this arrangement, it is supposed that the specified weights of ore, flux, and fuel, will be charged with the requisite accuracy. We are of opinion, however, that it leaves too much to the discretion of the workman. Where each charge is correctly weighed by the filler, the object sought is obtained, but as the operation is attended with considerable labor, and ab-

sorbs time, it is generally omitted in the absence of the superior agents, and in their presence is at best but a rough approximation to the actual weight. While so much is left to the judgment and principle of a class of workmen little superior to common laborers, it is not surprising that the operations of the blast furnace are subject to numerous irregularities in yield and quality, apart from those which may justly be attributed to atmospherical and other known causes.

The necessity of having the materials accurately weighed is generally admitted; but the labor and supervision demanded with existing appliances, is considered too expensive; it is desirable therefore to have machines which shall not add to the labor of the workman, or render necessary an expensive supervision.*

## SCAFFOLDS.

Obstructions to the descent of the materials technically termed "scaffolds," are traced to the adhesion of masses of semi-fused materials above and around the boshes. The primary cause we believe to be the increase of bulk which the fuel undergoes in its descent. Hence, coal-fed furnaces are more subject to scaffolding

* Some years since we impressed on the proprietors of the Dowlais works, the value of a self-acting machine which required no exertion on the part of the workman; and as in effecting a rigid economy of materials, a machine of this kind eventually must be adopted at the majority of works; we will briefly describe the principle on which it was constructed.

The frame-work and general arrangement was similar to the ordinary platform weighing machines; the platform being level with the surface, and so situated that the materials obtained from any given spot were compelled to pass over it. To the end of the lever on which the scale pan is usually hung, we attached a small hollow iron plunger, guided in a vertical direction by a slender parallel motion; the plunger worked in a small cylindrical cistern, partially filled with mercury. The levers were so arranged that a resistance of one pound to the descent of the plunger in the mercury was equal to a weight of one cwt. on the platform, and by proportioning the diameter of the plunger to the resistance, we obtained a stroke of 3 inches in the mercury to 12 cwts. of load, or about ¼ inch per cwt. with a descent of only one thirty-seventh part of an inch at the platform. Hence, a load being wheeled over the platform, the plunger descended until the resistance multiplied by the leverage equalled the weight. An index and pointer informed the workmen of the weight of the materials.

To render the machine altogether independent of the filler, a registering apparatus was attached to it, and the weight of each barrow load that has passed could be ascertained at intervals of several days. The circumference of a light metal cylinder was covered with paper sufficient for a week's working; the end of the plunger rod carried a pencil which was pressed against the paper by a slender spiral spring, the ascent of the plunger moved the cylinder around a distance of one twentieth of an inch. By this pencil, and cylinder covered with paper, every movement of the platform was accurately registered, and by referring to the measurements of the descending movements the agreement of the quantities charged with those ordered was easily ascertained.

than those fed with coke; and with coal-fed furnaces, the liability is increased by the sectional form of the furnace. If the throat is small, and the enlargement immediately below inconsiderable, the liability to scaffold will be very great.

Irregularities in filling will occasion partial obstruction in the deeper parts of the furnace, and variation in the quantity and quality of the blast at a tuyere, may produce similar effects. When it is known that a partial obstruction exists in the hearth, or bottom of the boshes, the furnace is turned on hot fluid gray iron; the weight of coal remains unaltered, but the proportion of ore and flux is largely diminished; a greater temperature being maintained, the refractory mass is gradually melted and a clearance effected. The operation may be expedited by turning on a larger volume of blast of undiminished density, proportionable to the more rapid consumption of carbon; similar measures are adopted, when from accident or other cause the hearth is partially filled up with cold infusible material.

A different course is sometimes pursued in the removal of obstructions which may have accumulated around and from the tuyere. Fresh tuyeres having been formed in the brickwork above the accumulated matter, the proportion of ore to fuel is largely increased; the alteration of burden is followed by the production of a sharp scouring cinder, which seldom fails to penetrate and carry away the obstruction. This remedy, however, requires to be used with great caution, or it entails effects on the furnace quite as injurious as those which it removes. The large production of scouring cinder, with a diminished consumption of fuel, reduces the temperature of the hearth below the point necessary for the separation of the metal and flow of the liquid cinders; hence, if the production of scouring cinder is of long continuance, there is danger of the lower hearth being filled with solid matter, for the removal of which, the original proportion of coal to ore is restored, if not exceeded, that a hot fluid metal may be produced. The high temperature now maintained, with the fluid character of the iron, gradually fuses the solid matter and cleans the hearth.

## TUYERES.

The height of the tuyere above the bottom, though usually dependent on the height of the cinder notch, is partly regulated by the quality of the coal and local custom. In some furnaces we have observed the centre of the tuyere placed 20 inches from the bottom, while in others it is as high as 48.

The extent to which the blast penetrates the hearth, is the principal distinction between the dark and bright tuyere. The quality of the fuel being similar, the soft voluminous blast is followed by a bright, while a dense concentrated blast produces a dark tu-

yere. The oxygen of the weak blast, absorbed by the fuel close to the tuyere creates an intense local heat, presenting to the eye, if examined through the blast pipe, a spot of dazzling brightness. But with a dense blast, the velocity of escape is so much greater, that the great body of the air is carried further into the interior of the hearth, the fuel next the tuyere is scantily supplied with oxygen, hence the dark tube, and the concentration of the heat in the centre of the hearth.

The bright tuyere is more common with weak spongy cokes than with those of a denser kind. The soft blasts formerly employed, entered the furnace through a cast-iron dry tuyere; the metal at the point being protected by a nose of fire-clay which was renewed at casting time, and on other occasions, when, from the stoppage of the blast or other cause it broke off into the hearth. If not immediately replaced the unprotected metal began to burn, the point of the tuyere was contracted, and the free admission of the blast being intercepted, the burning rapidly proceeded, so that it was not unusual to change the cast-iron shell at each casting.

The bright tuyere is universal with charcoal furnaces. This doubtless is owing to the soft blast generally used, and the large surface which the carbon of the coal presents to the oxygen of the air. An intensely high local heat is consequently produced, displaying the most perfect examples of the bright tuyere.

Tuyeres of this kind are occasionally seen with a dense blast, but if examined into, a sufficient cause is usually discovered. The most common defect, is removing the nose of the blast pipe to a great distance from the point of the tuyere. This causes the blast to diverge on escaping from the tuyere, and effects similar to those with a soft voluminous blast are produced on the fuel.

It is not an unusual circumstance with the bright tuyere to have accumulations of metal adhering to the point of the tuyere, thereby obstructing the passage of the blast. These adhesions, from being more common in certain localities than others, are supposed to arise from some peculiar property of the ore; but we have observed them to occur most frequently when the burden has temporarily been so rich in metal that the usual proportion of cinder to iron has not been maintained. Their removal is usually effected by damming up the cinder to a high level, so that the fluid bath in which they are immersed, eventually melts the iron, and allows of a free passage for the blast. In removing the adhesion, by thus elevating the cinder until it reaches a level above the entering blast, particular attention must be paid to the blowing engine that no stoppage of the blast occurs while the cinders are at this high level. Should the blast cease for a few minutes, the fluid cinder flows back into the pipes causing expense and delay in refitting.

The dark tuyere is produced by the dense concentrated blast,

causing the most active combustion at a considerable distance from the tuyere. The intermediate materials, deprived of the air necessary for combustion, are kept in a comparatively cool state, forming a species of vitrid tube for the passage of the blast to the central portions of the hearth. It is broken off by the pressure of the superincumbent materials in their descent after each casting, but its formation is commenced anew on the re-admission of the blast. Between the castings it will extend inwards from the iron tuyere from 12 to 20 inches. Should it extend further and fail to be broken off by the descending materials, measures are promptly taken for its removal. This is usually accomplished by iron bars, but if they fail to dislodge it, and the elongation continues, threatening to extend across the hearth, the tuyere is abandoned, and a fresh one cut out higher up the breast. The new tuyere, by fusing the materials at a higher elevation, eventually removes the refractory tube from underneath.

By some writers the formation of the dark tuyere is attributed to the use of a less instantaneously combustible coke, which at the tuyere orifice has its temperature lowered by an incessant discharge of blast. From our experience respecting its formation, we are led to a very different conclusion. That the nature of the coke has a greater or less influence on its formation we freely admit, but the density of the blast is the primary cause. We do not hear of this tuyere with charcoal furnaces being blown with a soft blast. It has arisen with the high density of blast rendered necessary by the altered form of furnace and successive enlargements of the hearth. With the soft blast of the charcoal furnace the air diverges, and is completely decomposed within a few inches of its entrance, but with the dense cold blast of modern furnaces it penetrates deeply amongst the materials, and the quantity which diverges in the vicinity of the tuyere is very trifling. Now, as the quantity of air brought in contact with the carbon of the fuel, in a given time regulates the degree of heat attainable, it follows, that the fuel next the tuyere, being sparingly supplied with this element, when a dense concentrated blast is used, the temperature maintained will be proportionably low.

We question the correctness of the late Mr. Mushet's opinion "that the coke has its temperature lowered by the blast." The heat evolved by the coke is the effect of the blast, and the supply of fuel being maintained, the degree of heat, and the quantity of caloric evolved, will be in exact proportion to the quantity of air projected into contact with the carbon of the fuel. A reduction of the temperature by the blast, is contrary to all laws of combustion. An inferior heat may be maintained at a particular spot, but this inferiority is the result of a diminished supply of air to the carbon, and not an excess, as this author states.

A soft blast and highly porous coke invariably produces a bright tuyere, and the cause is sufficiently evident. The loose

blast diverges on its emission from the tuyere; a large portion of the air is thus brought immediately in contact with the fuel, which by its porosity, spreads the carbon over a large surface; hence, the rapid combustion of the fuel, and the high temperature maintained at the tuyere. With a dense blast the case would be different; the volume of blast would be projected further into the interior, the materials next the tuyere from being deprived of the air for combustion would exist in a comparatively cool state. But in many districts, the fusibility of the coke will not allow of a dense blast being employed.

Blowing into the cinder is extensively practised in some districts, and is followed to some extent at several Welsh works. The centre of the tuyere is usually placed 4 or 5 inches above the bottom of the cinder notch in the dam-plate, but this is sometimes reduced to 1 or 2 inches, and where blowing into the cinder is practised, we find the centre placed as much as 5 or 6 inches below the notch. When thus situated a dense blast is required to keep back the cinder, and great care is necessary with the blowing engine, that no stoppage of the blast occurs except at casting time. And care must be taken that the depth of the tuyere in the cinder is not greater than the descent of the materials after the metal has been tapped.

We consider the blowing into the cinder as being more applicable to narrow than wide hearths. When the breadth is small, the mean temperature within the zone of fusion is proportionably high, and the fuel within this contracted space is consumed too rapidly to yield a maximum effect. This is partly obviated by blowing into the cinder. The ascending column of heated air, on reaching the zone of fusion, is equally distributed through the entire mass of materials, maintaining a less powerful but more lasting combustion.

It was formerly supposed that blowing into the cinder would result in a deterioration of the quality of the iron, in consequence of the thinner stratum of cinder which protected it from the oxidizing influence of the blast, especially towards casting time, when it is thinnest; and were the thickness reduced below a certain point, this undoubtedly would occur. But under ordinary circumstances, the stratum of cinder is from 18 to 30 inches in thickness, or from 3 to 5 times that of the metal underneath; it may, however, be diminished to twice without injury to the quality of the iron, consequently the tuyere may be brought so much lower and nearer the surface of the fluid iron.

Bright tuyeres are usual with the hot blast. They have been accounted for on the supposition that the heat carried into the furnace increased the temperature around the tuyere. We are of opinion that the cause of bright tuyeres with a hot blast, is to be found in the more perfect union of the oxygen of the air with the carbon of the fuel at the tuyere. The heated blast does not

penetrate so far into the interior of the hearth as a cold blast of the same pressure. The elevation of the temperature to the melting point of lead, more than doubles the volume of the blast, and since heat is not considered a ponderable matter, this expansion is followed by a corresponding reduction of the specific gravity. Now, the distance to which the blast penetrates the materials is due to the momentum acquired by the atoms of air in their exit under pressure from the pipe, and if by heating, the specific gravity of the volume of air is diminished, as in the case with the hot blast, the momentum acquired will be diminished, and the ability of the blast to penetrate the materials, reduced in a precisely similar ratio. Hence, the hot blast in its effects at the tuyere, is analogous to a soft voluminous blast, creating a high local temperature, and the bright tuyere.

The experiment of blowing into the furnace through a tuyere situated above the boshes, has been tried more than once at the Dowlais works. By some practical smelters it is held, that blowing at this elevation would augment the temperature of the descending materials, lighten the work at the lower tuyeres, and result in a larger produce of iron from the furnace. But the results with the elevated tuyere were very unsatisfactory, though such as on attentive consideration might have been anticipated. The blast poured in on the materials at the high elevation, caused a high local temperature, which threatened to destroy the surrounding brickwork of the furnace. A portion of the fuel was consumed, partially fusing the adjacent pieces of ore, rendering them less permeable to the ascending gases, and more infusible in the hearth. Hence, the consumption of coal was doubly increased; first to compensate for the fuel consumed at the upper tuyere; secondly, from the greater infusibility of the semi-fused ore. Although there was no means of ascertaining the point with the accuracy we desired, the evidence obtained showed that the fuel consumed at the upper tuyere had to be made good in the quantity arriving at the bottom, and a nearly equal quantity in addition; the latter, from the altered condition of the ore, rendering it more difficult of reduction.

## QUALITIES OF THE CRUDE IRON.

### *Produced with the Different Classes of Ores.*

The relative proportions of ore, fuel, and flux employed, varies considerably in the same locality, while the variations between districts using the same class of ores is very great. At some of the large Welsh works, an assayer is maintained for the purpose of assisting the furnace-manager in determining the proportion best adapted for the iron to be manufactured; but at the majority of works, the proportions adopted are the result of experimental trials made on the furnace; we may remark, often

with a waste of materials, injury to the furnace, and loss through a deficiency of make, amounting on the whole to a large item in the cost of production. Too much importance cannot be attached to the necessity of having all the materials that enter the furnace properly analyzed; unless this is done the resulting pig iron will be of uncertain quality, and the consumption of iron-making materials, fuel and flux, may be below or above the requirements of the case. It is the more necessary now that the consumption of hematites and silicious ore is on the increase. The yield of metal from these ores varies considerably, being in some cases less than one-eighth of that from others; although the higher percentage is generally distinguishable by its greater specific gravity, no less short of actual assay should be relied on. Richness in metal is the chief consideration with iron-masters, but an ore may be poor in metal, and yet more valuable than one containing it in greater abundance. If lime is combined with it in considerable quantities, it may be used as an ore, and the excess of lime will act as a flux for other ores. Again, if it contains a large percentage of carbonaceous matter, the cost of smelting, owing to the reduced consumption of fuel and flux, may be so low, that metal is manufactured at a cheaper rate than from richer ores. Indeed, with our present knowledge of the blast furnace, an ore containing a comparatively high percentage of metal, but which has in combination a large quantity of silica, cannot successfully compete in the cost of manufacturing with poorer ores having carbon, alumina, or lime as their base. The real value however of any ore at a given spot, can be determined only by the results of an accurate analysis, being compared with that of other ores.

To produce pig metal of the best quality a single variety of ore is used. The production of a far superior iron with a mixed burden is difficult and uncertain. The form of the furnace may be well adapted for one, and the proportion of fuel, flux, and blast harmonize with this ore, but be altogether unsuitable for the other. Hence, the best pig iron is invariably smelted from a single variety of ore, with the necessary fuel and flux.

The qualities of the crude iron which the respective classes of ores are capable of yielding in the blast furnace differs greatly, and the qualities of the malleable bars manufactured from the pig, varies also with the description of ore used.

The superiority of the metal produced from one ore over that from another, arises from the greater or less fusibility of the combined earth. The melting temperature and quality of the pure metallic iron are the same in all ores. Its strength, and various other properties, however, are affected by the presence of exceedingly minute quantities of earthy matter. The greater the volume of the combined substances, the weaker and more inferior the pig iron. When a definite volume of foreign matter, composed of several substances, is present, the quality is not so low

as with a similar volume of one substance only. The presence of a single earth in quantity suffices to deteriorate the quality to that extent, that it is rendered comparatively valueless for all purposes requiring strength and ductility.

We have stated that the quality of the metal is the same in all ores. This is an obvious truth; for to maintain otherwise is to assert that pure metallic iron instead of a simple is a compound metal. The iron of commerce is a compound of metallic iron and other substances. The crude iron from the blast furnace consists of iron alloyed with carbon, silica, and alumina, in varying proportions; other substances enter, in minute quantities, into its composition. The malleable iron of commerce, and the various productions manufactured therefrom, are alloyed more or less with carbon, silicon, and other substances. Each substance in alloy tends to debase the quality of the metal; but the degree of deterioration is not equally great with all substances. Absolutely pure iron is a rarity, and cannot be manufactured in quantity with our present knowledge of metallurgical operations.

In smelting a particular ore, the smelter designates the resulting metal as good or bad iron. Certain ores are rejected as producing iron of a quality too low for manufacturing purposes; for although the quality of the metal in the ore is unvarying, the crude iron produced, owing to the impurities in combination, is of very varying quality. Hence, the terms good and bad iron, as applied by the iron-master. These terms we shall employ in a similar sense in our inquiries; and unless otherwise specified, pig and bar iron of commerce is intended.

The crude iron obtained from ores of the argillaceous class is the best which this country affords. Combined with alumina, silica, and lime, the ore after calcination is of an open, porous texture, offering an extended surface for the action of the carbon of the fuel, as gaseous and solid carbon. The earthy matrix combining with the lime used for fluxing, forms at the temperature maintained by the blast, a fluid cinder, from which the metallic iron readily separates in a comparatively pure state. From this crude metal malleable iron possessing great tenacity and ductility may be manufactured.

The carbonaceous ore has in combination with the metal, carbon, alumina, silica, and lime, and occasionally small quantities of sulphur, manganese, and magnesia. By calcination, the sulphur is partially sublimed, and the carbonaceous matter consumed. The remaining substances in alloy combine with the limestone flux, forming a cinder fluid at a lower temperature than that flowing from argillaceous ores. From this cinder the metallic iron separates by its superior gravity; but owing to the inferior quantity of cinder produced, and the lower temperature at which it melts, the separation of the metal is not so perfect as with the majority of argillaceous ores. In consequence of the quantity of

carbonaceous matter combined with the ore, and the excessive quantity of fuel used in proportion to the liquid products obtained, the resulting metal is alloyed with a large percentage of carbon, and minor quantities of alumina, silica, and manganese. It is inferior in strength and hardness, but, melting at a lower temperature is preferred to the argillaceous smelted iron, where fusibility and softness are desired. From the comparatively low temperature at which it melts, the conversion of this metal into malleable iron is attended with greater waste, and the finished bar altogether is inferior to that from argillaceous ore.

Iron ores of the calcareous class, contain lime as their chief earthy alloy, alumina and silica in inferior proportions. Lime is sometimes present in sufficient quantity to smelt the ore without additional flux; in some ores it is in excess. When this occurs, the complement of clay is made up by the addition of burnt argillaceous shale. As a consequence of the large percentage of lime in comparison to the other earthy matters carried by these ores, the cinders produced are thin and exceedingly fluid. From this cinder the metal readily separates, falling to the bottom, but holding in solution a small percentage of cinder. This being composed chiefly of lime, the metal produced consists of iron alloyed with silica, alumina, and lime. It is inferior in strength and hardness to the iron smelted from the argillaceous ores. Manufactured into malleable iron bars, it possesses great strength and ductility when cold, but is brittle at a red heat. This red-short property is eminently characteristic of iron smelted from calcareous ores, and constitutes a defect for which no remedy hitherto has been discovered.

The class of ores termed silicious, from their containing a large percentage of silica, with inferior quantities of alumina and lime, are not extensively used in the manufacture of iron. From the large proportion of silica, the quantity of lime required for fluxing is greater than with the other classes. And the excessive yield of silica renders the cinder infusible at the temperature maintained with other ores. A high temperature therefore has to be maintained, and with the increase of temperature an increased consumption of fuel takes place. The liquid cinder is large in quantity, but of too thick a consistence for a perfect separation of the metal. This falls below, alloyed with a notable portion of cinder. The metal is composed of iron, alloyed chiefly with silica, alumina, lime, &c., being present in minute quantities. It is inferior in strength, and fuses at a higher temperature than either of the foregoing metals. From this last circumstance its conversion into malleable iron is attended with greater expense in fuel and labor, and the finished bar is hard and brittle. The cold-short principle is strongly developed in all iron, manufactured from silicious ores, and not unfrequently such iron is red-short also. In short, the general quality of the metal from sili-

cious ores, is greatly inferior to that from any other class, and no improvement in its quality is effected in its subsequent manufacture into bars.

From this great variation in the qualities of the metal produced from the different classes of ores, we conclude that the quality is affected chiefly by the earthy matrix. The qualities of the fuel and flux employed also directly influence the quality of the metal. Where a particular earth predominates in the ore, the resulting crude metal will be alloyed chiefly with that earth; and we observed in Scotch pig-iron, smelted from the carbonaceous ores, that an excess of carbon in the operation is followed by the production of a highly carbonated metal, greatly deficient in strength and hardness. But the silicious ores are most difficult to manage. The silica combined with the metal is infusible at ordinary temperatures, and during the processes of manufacture in the forge and mill, it is incorporated in the bar to the manifest injury and deterioration of the metal for commercial purposes.

Iron ores having carbon, silica, lime, and alumina in nearly equal portions, would smelt with the greatest facility, and produce metal of superior quality. The percentage of metal being equal, the ore which contains these substances in the greatest uniformity, is the most valuable. In the manufacture of malleable iron, this equality of the earthy basis is attended with the best results; for since the red and cold-short principles in bar iron are mainly owing to an excess in one or other of these earths, their presence in nearly equal portions would conduce to the production of metal free from such defects.

This property of the calcareous and silicious ores of producing iron debased by the presence of an excess of lime in one case and silica in the other, is an effectual barrier to their being worked alone in the blast furnace, when the metal is intended for conversion into malleable iron of superior quality. And in the matter even of castings—except such as are for ornament or dead weight—these metals do not possess the requisite strength for machinery subject to vibration and working under great strain. The defects in metals from these ores are now well understood, and the smelter combines them with an equal or superior weight of argillaceous ores, in order to produce metal suitable for the forge. But the defects common to each ore will appear more or less apparent in the finished bar. If a silicious ore has been used, the metal will be hard, and the cold-short principle developed in proportion to the quantity of ore used. If calcareous ores, the red-short tendency of the metal will prevail in a similar ratio. By mixing all three, argillaceous, calcareous, and silicious, the resulting metal will exhibit, in the manufactured bar, the defects incidental to an excess of the predominating earth of the mixture.

The addition of either of these ores to the argillaceous ores,

results in the production of a metal inferior to that from the clean ore. Mixing an inferior with a superior metal cannot result in the production of a metal superior to either. The metal from the mixed burden may possess certain properties, but abstractly the quality is debased. Yet we frequently observe these ores used for improving the argillaceous ores of the coal formations. That the use of the rich ores results in an increased produce of iron from a given size furnace, must be conceded; but of the improvement in quality we have no evidence.

In South Wales, the argillaceous ores are invariably selected for conversion into superior iron. But a considerable difference in the quality of these ores is observed, though extracted from the same mine; for while the best produce, when smelted alone, iron of the finest quality, equal indeed to any smelted in this country, the metal from the others is of a coarse inferior quality. Having ascertained from observations and experimental trials the great superiority of certain seams, the iron washer selects these for the production of pig iron for foundry purposes, and for the manufacture of cable bolts, and other wrought bars requiring metal of the finest quality.

(To be continued.)

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ART.—IV. ON THE SANDSTONES OF NEW JERSEY, NEW BRUNSWICK, AND CONNECTICUT. By FRANCIS ALGER, Member of the Society of Natural History, and of the American Academy, Boston.*

MR. ALGER confined his statements to the sandstones above named in reference only to their comparative value as building materials. He did not design to speak of their local geology. He said that samples of them had been placed in his possession to examine and report upon. He was aware that the subject was not one likely to command the deepest interest of a purely scientific association like this, at whose meetings, especially of late, the discussions have appertained to some of the higher departments of human knowledge; but, though of inferior interest, they have an important practical and economical application, and are such as properly come within the circle of objects which our society endeavors to promote.

The first specimen is from the Bay of Fundy or New Brunswick, taken from the quarries owned by C. D. Archibald, Esq. It is a brownish red variety, of a fine gritty texture and of uni-

* Proceedings of the Boston Society of Natural History. Allusion having been made by several writers in this Journal to Mr. Alger's paper, we have concluded to give it entire. Mr. Alger predicts that the beautiful Quincy *Granite* will yet find a market in the Cities of the Old World.

form color. It contains no scales of mica, and it has the specific gravity of 2.48. The coloring matter, peroxide of iron, exists only in the cement by which the particles of quartz are held together; for the pulverized stone, after being subjected to the action of hydrochloric acid, remains a colorless and nearly transparent sand. It contains no carbonate of lime and no sulphuret of iron, either of which would essentially injure the stone as a building material. A mass which had been exposed to a dry temperature of 75 to 80 degrees several days, absorbed, when immersed in pure rain water, 3 8-10 per cent. of that fluid. This was the greatest quantity it would take up; for whether exposed 8 hours or 48, no more would enter it. The mass appeared very compact and free from seams, and it showed no greater tendency to crumble after being immersed thus, and subsequently heated, than it did before. In hardness and tenacity it is greatly inferior to marble or granite, though there are some inferior kinds of granite in use which will scarcely resist a greater crushing force applied to it. A cubic foot of this freestone, calculating from its specific gravity, weighs one hundred and fifty-five pounds.

The sample from New Jersey is a grayish white sandstone, two or three shades lighter than that just described. It is less uniform in its general appearance, but the hardness and frangibility of both are about the same. It contains a few minute spangles of mica, but neither carbonate of lime, nor sulphuret of iron. Examined by the microscope, here and there, we notice a few dark spots, which seem owing to the decomposition of sulphuret of iron. Its specific gravity is 2.37, or rather less than that of the first specimen. A mass exposed under precisely the same circumstances with that as to temperature, absorbed 5 8-10 per cent. of pure rain water, thus exceeding it about 2 per cent. in its capacity for taking up the liquid. Its absorption was more rapid and attended with a hissing sound, as of hot-air bubbles escaping at the same time from the pores of the stone. As it takes up water more readily, so it will probably part with it sooner than the first sample; and thus it will be more liable to crumble from sudden expansion and contraction, caused by changes of temperature in the atmosphere, or opposite states in the hygrometric condition of the stone. A cubic foot of this stone, estimated fom its specific gravity, weighs one hundred and forty-nine pounds.

The Connecticut specimen is of a darker shade of color than the first, and of a coarser texture, not at all uniform, some parts being fine and granular, and others formed of nodules of flint or quartz. It contains more oxide of iron than the first specimen, and is largely impregnated with mica and carbonate of lime; less frequently with feldspar and sulphuret of iron. The carbonate of iron may have an injurious influence in two ways; for by the escape of its carbonic acid gas, in case of fire, the walls of a building constructed of this stone would speedily crumble and fall; or

the same effect might be more slowly produced by the decomposition of the pyrites, and the formation of sulphuric acid, which would seize the lime, and thus cause its disintegration. Its specific gravity is 2.51, or it is a little heavier than the first specimen. Exposed in a similar manner with that to the influence of pure water, until it is saturated, 2 3-10 per cent. is absorbed. This less susceptibility to absorb water is owing to the numerous quartz-pebbles contained in the stone, which are not at all penetrated by it. They are much stained by iron, as is the cement by which they are held together. In fact some samples of this sandstone contain 15 per cent. of peroxide of iron, and this gives additional hardness to the stone, as well as increases its weight; for a cubic foot weighs one hundred and fifty-seven pounds under the same circumstances with the other samples.

These sandstones belong to the sedimentary group of rocks known either as new red or old red sandstone, and are such as accompany coal formations. They are similar to the sandstone grits, or carboniferous sandstones found near Glasgow and Edinburgh, Scotland, and in Yokshire and Derbyshire, England, of which numerous public and private edifices have been erected; for example, Melrose Abbey, built in 1142, and the celebrated cathedral of Glasgow, erected about the same time. Windsor Castle, Whitby Abbey and Eccleston Abbey, (Yorkshire,) are of the same material, and were built in the 13th century. On some of these buildings, the mouldings and decorations, such even as the dog's tooth enrichments, are yet in perfect condition.

It is to be understood that quarries produce stones of very different qualities, as to durability and tenacity, and even of different shades of color—these latter modifications depending upon the proportions of iron diffused through the mass. Many of the strata are so friable and porous that blocks taken from them will soon show incipient signs of decomposition, and in a few years will crumble in their most exposed parts. This is strikingly shown in some of the edifices before alluded to: and even the Hunterian Museum in Glasgow, although built in 1804, gives proof in many places that the architects were not careful enough in selecting their material. I mention these facts, to show that sandstone is a valuable building material, and has been much used in the construction of the most splendid edifices. Many of the sandstones of Great Britain contain carbonate of lime, and almost all of them mica, in the planes of stratification. Excepting that they are usually of a lighter color than the sandstones of this country, they have the same lithological character. The admixture of carbonate of lime, especially if it should be united with sulphuret of iron, as is sometimes the case, imparts an injurious quality to the stone, and causes it to crumble, by the spontaneous formation within it of sulphuric acid, which attacks the lime. The same disintegrating effect would be produced on the lime, if the

wall of a house should be exposed to the fire—say to the burning of a building in close proximity to it. The carbonic acid would be driven off.

For all reasons let our architects use every caution in deciding upon the choice of their building material. It is undeniable that a perfect sandstone would, under the circumstances last named, prove itself altogether superior to marble, or granite, or even brick; for the reason that it is a fire-proof material, and is often applied in situations where the effects of the heat are to be resisted. The score of cheapness would thus recommend it with double propriety, but people do not build under the apprehension of such casualties. In our climate the prolific cause of decay is the expansion and contraction of the stone by the gain and loss of water. This may be prevented to some extent by painting—an expensive remedy, which greatly impairs, if it does not destroy, the external beauty of the stone. A most melancholy proof of this fact is presented by the Capitol in Washington. In all cases the blocks of stone should be placed in the building with their planes of stratification horizontal (not vertical), conformably to their geological position in their native beds; otherwise the layers will be thrown off by the frost or other expansion, which could not act upon them if placed in an opposite direction; the regular superposition of block upon block, binding the whole together, and presenting what may be regarded, in fact, the end of one vast stratum—the edges, only, of the layers composing it being exposed to the action of the atmosphere. These considerations are also applicable to certain granites, the micaceous or gneissoidal granites, for example, which are frequently composed of layers so slightly coherent as to be thrown off if placed with their broad surfaces exposed to the weather. The Quincy Granite, or more properly *Sienite*, is free from any such liabilities, for the reason that there is nothing of a laminated structure belonging to it, and one situation of exposure is no less favorable than another. It is not surprising to me that this stone is finding its way into all the cities upon our sea-shore. I am even willing to predict that its unrivalled superiority, both for durability and beauty, over every other building material, will insure for it a market in some of the cities of the old world. The monuments of Egypt furnish nothing superior to it, and there is not a building in England constructed of its own material, which will not have passed away, ere the tooth of time has made scarcely any impression upon yonder structure upon Bunker Hill.

I was about to say that some of the English sandstones which have been used quite extensively, absorb nearly one-fourth of their weight of water; and from this cause Durham Castle, which is also built of a stone of this sort, shows evident marks of decomposition. The stone of the Capitol in Washington, already alluded to, is very similar to them, and it is well known that this

edifice is now undergoing rapid dilapidation—perhaps hastened in some degree by the burning of the interior of the building by the British.

My opinion in regard to the samples placed in my hands is, that the two first possess nearly the same character of cohesion and hardness, under similar circumstances of exposure. The less susceptibility of the New Brunswick specimen to absorb water, arising probably from its finer grain and greater compactness, is certainly in its favor, and more than counterbalances the injurious effect of the oxide of iron contained in it. The absence of mica is also in its favor, as it shows a less laminated structure. It is probable that the finest grained variety from both of these localities will prove the best, and I am inclined to think they are fully equal to the best sandstones employed now, or formerly, in Great Britain. In fact, the circumstances before named, viz., the absence of carbonate of lime in both these varieties, must give them a decided superiority over the foreign article, should they ever be exposed to the action of fire.

Trinity Church in New York, the Church of the Saviour in Bedford-street, and the new Athenæum, Boston, are of this stone, from New Jersey. The stone forming the front and side of the new church at the corner of Rowe-street, is from Connecticut. The New Brunswick stone, if carefully selected, is as beautiful as the former, and will probably prove to be more durable, for the reasons already given. The ease with which it is obtained and brought to market, will give it an advantage over the other kinds on the ground of cheapness. The specimen exhibited to you is an average one, such as may be obtained in thousands of tons without any material variation. Such, also, is the average character of the other specimens upon the table. As to the Connecticut specimen, while it is heavier and less absorbent of water than either of the other two, it has a distinctly laminated structure, and is not uniform in its grain. From the great portion of iron it contains, to say nothing of the carbonate of lime, which, in case of fire, would cause it to crumble away, I am inclined to value it less as a building material than either.

Such, then, are the conclusions to which the foregoing experiments and observations have led me. I have had no opportunity of comparing other kinds of sandstones with those here spoken of, such, for example, as occur along the valley of the Connecticut, in this State, or the material more recently brought into market under the name of Native Sandstone from New York. In conclusion, I would call attention to the experiment recommended by Dr. Ure, of Glasgow, for testing the durability of sandstone, which, I am told, has proved very successful in Great Britain, though its application in this country may not be followed by the same results, owing to the greater severity of our climate. He proposed to immerse a portion of the stone in a saturated solution

of sulphate of soda. If exposed to the action of the air for some days, crystallization will take place within the stone, and cause the same disintegration that would follow from the influence of frost. This test will make the inferiority of all freestones compared with granite more apparent, and will eventually lead to disuse of them altogether as a material for the outer walls of buildings. He observes that "there is scarcely a public building of recent date in Great Britain, that will be in existence a thousand years hence; while, but for the destroying hands of modern barbarians, in peace and war, most of the temples and other public monuments of Greece and Rome would have remained perfect at the present day, uninjured by the elements during 2000 years."

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ART. V.—THE PRODUCTS OF ENGLISH MINES AND COLLIERIES.
By R. G. RANKIN. No. 1.

THE Mining Magazine has done much to give a practical form and value to the mineral resources and enterprises of the United States, and I know of no work of its kind so well deserving the attention of parties engaged in developing our great mineral resources. The great desideratum in our country, where we have no schools of mines, &c., is reliable and practical information, not only in regard to our actual natural resources in deposit, as well as cost of development and market for the produced article; but also, in regard to the present resources, production, and probable future supply by foreign countries of similar articles. We require more reliable statistical information of our own and foreign markets, that, by the comparison of values, our capital and enterprise may not be lost by unwise or speculative calculations. The wild spirit of speculation has ruined thousands, and under circumstances where a little practical knowledge and means of comparing our own with other resources and productions, might have resulted in remunerative investment.

It is a fact worth remembering, that of all our industrial resources, those have been most *permanently* successful which have been at first barely remunerative. The solution of the fact is within the knowledge of those acquainted with mining operations and Wall-street values.

For the purpose of affording some standard of comparison between foreign and native metallic products, I propose to present, from time to time, some statistical tables, derived or made up from official and reliable resources, of the products of Great Britain in tin, lead, silver, copper, coal, iron, &c., and shall begin with tin, although all our marketable tin is imported.

TIN, 1853.

The great tin-bearing districts of Great Britain are Cornwall and Devonshire.

| | tons. |
|---|---|
| Total quantity of tin ore raised in Cornwall and Devonshire, 1853. | 8,866 |
| Average product of metallic tin from ore, 65 per cent., or | 5,763 |
| Average value of ore, £68 per ton, or | £593,088 |
| Average value of metallic tin £112 to 118, say | £700,000 |

IMPORTED INTO GREAT BRITAIN, 1853.

| | |
|---|---|
| Tin | 2,487 tons. |
| Tin ore and regulus | 156 " |

EXPORTED, 1853.

| | |
|---|---|
| British tin | 1,277 tons. |
| Foreign " | 1,072 " |

TIN, 1854.

| | |
|---|---|
| Tin ore raised | 8,747 tons. |
| Average product, 69¼ per cent., say | 5,947 " |
| Average price ore. £68 per ton | £559,808 |
| Average price metallic, £114 to £118, say | £690,000 |

TIN IMPORTED INTO GREAT BRITAIN, 1854.

| | |
|---|---|
| Tin | 2,251 tons. |
| Tin ore and regulus | 66 " |

TIN EXPORTED.

| | |
|---|---|
| British | 1,405 tons. |
| Foreign | 668 " |

COAL.

| | |
|---|---|
| The area of bituminous coal in Great Britain, is | 8,139 sq. miles. |
| The area of anthracite coal in Great Britain, is | 3,720 " |
| The production of coal at Pits, Great Britain, 1854 | 64,661,401 tons. |
| Value at current prices for the year, | £14,975,000 |

NUMBER OF COLLIERIES.

| | | |
|---|---|---|
| Wales | 306 | 2,397 in the United Kingdom. |
| England | 1,704 | |
| Scotland | 368 | |
| Ireland | 19 | |

General summary of the *Mineral Produce* of the United Kingdom in 1854, valued at the current prices of the year.

| | | |
|---|---|---|
| Tin | 5,763 tons. | £690,000 |
| Copper | 13,042 " | 1,229,007 |
| Lead | 64,005 " | 1,472,115 |
| Silver | 700,000 ounces. | 192,500 |
| Iron, pig | 3,069,838 tons. | 9,500,000 |
| Coal at Pits | 64,661,401 " | 14,975,000 |
| Zinc | | 16,000 |
| Arsenic, sulphur, ores, and sundry minerals | | 500,000 |
| | | £28,575,922 |

(To be continued.)

ART. VI.—THE MINING OF COAL,* &c., &c. By A. T. PONSON. No. 4.

[Translated from the French, for the Mining Magazine.]

## SECTION 8.—THE COVERING STRATA.—THE ORIGIN OF THE WATER IN COAL MINES.

### 29.—*Of Dead Ground in general.*

COAL basins appear under three distinct aspects. Some have no other covering than a seam or layer, more or less thick, of vegetable earth, so that a small trench is sufficient to expose the croppings of the coal; some are partially covered by more recent formations; others, in short, are entirely hidden by sterile ground. The latter are at present unknown; the former are very rare, and almost the whole of the deposits belong to the second class, among which can be named the great carboniferous zone of Belgium, uncovered in the larger portion of the basins of Liege, Namur, and Charleroi, and covered every where else by secondary and tertiary strata.

When the miner finds below the soil which supports vegetation, only some thin deposits of sand and clay, and, consequently, of little importance as respects their springy character, he meets no obstacle in penetrating to the coal formation. But, if the superincumbent strata possess a certain thickness, and, in addition, abound in springs, it should engage all the attention of the workmen, because of the great expense involved in the works which it will be necessary to resort to, and the vast, and sometimes insurmountable, difficulties of the labor. This kind of formations covers a large portion of the carboniferous deposits of the province of Hainaut and the whole of the department of the North. They have been called dead ground by the miners of these localities, because they never contain any coal.

These dead grounds, usually possessing springs, and liable to "cave in," or break down, present great obstacles to the sinking of pits; but still the miner is not under an apprehension of falling into unknown and flooded works, so frequently to be met with in localities where the coal outcrops. In addition, when the passage is made through these stratifications, so difficult to work, the subsequent works are usually guarded from water by the impenetrable nature of the lower beds. In short, they are an obstacle to the irregular workings to which the owners of the surface are so much disposed—a method of working which is always to be regretted so far as relates to the yield of the works below, as they form reservoirs, the contents of which are filtered into the mines.

* Continued from page 225, vol. 6.

The dead grounds, such as we can designate, in applying the term indiscriminately to all the covering strata of inconsiderable thickness, belong to three formations: The alluvial, tertiary, and secondary strata. These formations present themselves, sometimes isolated, sometimes superincumbent and reunited two by two, or three by three, according to the localities. They have been deposited since the coal series was elevated and dislocated, as they are in manifestly horizontal layers, without any correspondence with the lower strata.

### 30.—*Alluvial Strata.*

These are usually composed of deposits of sand, masses of gravel or round pebbles, and beds of pure clay, or a mixture of sand in various proportions. These strata, situated on the sea-coast, the shores and streams of rivers, are never much elevated above the level of the water. They are very recent, since the elements of their formation are at present actually deposited. Indeed, their extent and depth are often considerable.

Such are the alluvials of the Sambre and Meuse rivers, composed of sand and gravel, and those which rest upon the coal formation of the Maine-et-Loire and the lower Loire. These latter are composed of beds of clay, with a mass of sand intervening, forming a thickness of 18 to 20 metres. The sand, which is in grain very fine near the surface of the ground, grows insensibly more coarse in descending, and becomes pebbles, and afterwards, in the lower part of the formation (boulders), the angles of which being reduced by friction, they assume a spherical form. We recognize in the fragments of volcanic rocks, granites and silex, the debris transported by the current of the Loire. The borings made by M. Triger have demonstrated that the surface of the coal strata is perfectly smooth and level, a circumstance which can be ascribed only to the erosion which took place before the deposit of sand.

We can classify, likewise, among the alluvial rocks, the water-carrying yellow sands, superincumbent in the basin of Newcastle and in the valleys of rivers; their thickness, usually between 4 and 6 metres, is otherwise very variable, and sometimes sufficiently great to present serious difficulties in sinking pits.

### 31.—*Tertiary Strata.*

These formations consist equally of sand of different colors, agglutinated together, or wholly separated, in beds of clay, more or less pure, and in mixtures of these two substances in different proportions. We frequently meet with nodules of silex, fragments of coal and accompanying rocks, scattered in the mass; trunks of trees, also small vegetables partly decomposed, shells, and, more rarely, the remains of marine animals. It is to this

class of strata, generally deposited upon places which are more elevated than the actual level of the streams of water, that the sand and clay deposits belong which cover a part of the coal formation of Centre (Hainaut). Beneath the soil of vegetation, and a bed of one or two metres of clay, suitable for the manufacture of bricks, we meet with 5, 20, and even 50 metres of argillaceous sand, sometimes green or blue, containing pebbles of silex, and in its midst, also, at times, scattered trunks of prostrate trees, the nature of which we easily can distinguish, notwithstanding they are in a very advanced state of decomposition. Crystals of sulphuret of iron are attached to these trunks. At some points in the basin, the thin sand reposes upon beds of plastic clay, used in potteries.

The following is a section of the strata penetrated by the pits Sante Marie, of the mine of the Louviere (district of Centre).

| | | | |
|---|---|---|---|
| 1. Vegetable soil and yellow sand, | Metres | 2.30 | |
| 2. Blue clay, | | 5.70 | 2.30 |
| 3. Clay with springs, | | 2 | 8 |
| 4. Ib. mixed with sand and round pebbles, | | 2.50 | 10 |
| 5. Silex, called *rabats*, | | 2.50 | 12.50 |
| 6. Green sand and gravel, | | 2 | 15 |
| 7. Green sand mixed with white pebbles, | | 9 | 17 |
| 8. Coal strata, | | | 26 |

Borings which have been made further to the south, near the village of Haine-St-Paul, have demonstrated the existence of the following strata:—

| | | | | |
|---|---|---|---|---|
| Alluvial Strata. | 1. Vegetable soil, | Metres, | 0.70 | |
| | 2. Gravel and sand, | | 5.90 | 0.70 |
| Tertiary Strata. | 3. Green sand and pebbles of silex, | | 2.70 | 6.90 |
| | 4. Gray sand, | | 7.46 | 9.30 |
| | 5. Green sands and pebbles of silex, | | 0.73 | 16.76 |
| | 6. Yellow sand agglutinated, | | 12.86 | 17.49 |
| | 7. Gray silicious rock, | | 8.23 | 30.35 |
| | 8. Argillaceous sand, | | 3.21 | 38.88 |
| | 9. Argillaceous sand at first, afterwards quicksand, | | 8.06 | 41.79 |
| | 10. Coal strata. | | | |

The sandy strata which repose upon the coal deposit of Glasgow consists of:—

| | | | |
|---|---|---|---|
| 1. Dry sand, | Metres, | 5.50 | |
| 2. Sand with springs, | | 6.40 | 5.58 |
| 3. Clay, | | .201 | 11.90 |
| 4. Coal Strata, | | | 13·10 |

### 32.—*Superincumbent Secondary Formations.*

We find in many parts of the basin of Newcastle, a motley sandstone and magnesian limestone superincumbent on the coal

sandstones. Deposits of red sand of the triasic epoch (motley sandstones and variegated clays) cover five-sixteenths of the basin of Saone-et-Loire. The lias is superincumbent on the coal formations of Alais and Grande Combe, France. The coal strata of Vendee is hidden by the Jurassic strata. Most of the districts of Silesia are covered by red sandstone and shell limestone. In short, the formation of Saarbruck is buried under the motley sandstone of Vosges. But the deposits of the secondary formation, which are the most remarkable as relates to the art of mining, are the cretaceous strata, which extend over the carboniferous formation of the department of the North, covering the greater part of that of the Couchant de Mons, and advancing eastward beyond Binche. They are formed of alternate beds of marl, sand, clay, and chalk, belonging to the formation of secondary rocks, and placed in the geological scale between the jurassic limestone and the coarse limestone.

The following sections will give the reader a general idea of the composition of the dead strata deposited in these localities.

*Superincumbent Strata penetrated by the Pits Saint Zoe (No. 14), in the mine of Levant du Flenu, near Mons.*

| | | Thickness of Strata. | Depth beneath Surface. |
|---|---|---|---|
| Lower Tertiary. | 1. Vegetable soil and clay, Metres, | 1.20 | |
| | 2. *Ergeron*, . . . . | 4 | 1.20 |
| Upper Cretaceous Strata. | 3. Yellowish *marlettes*, . | 11 | 5.20 |
| | 4. Limestone rock (3 beds), . | 10.10 | 16.20 |
| | 5. *Marne* of the miners, white chalk, | 28.90 | 50.20 |
| | 6. Marne (white, 5 beds), . | 4.20 | 50.20 |
| | 7. Idem, compact, . . | 8.10 | 54.40 |
| | 8. *Gris* (4 beds), . . | 5.30 | 62.50 |
| | 9. Three beds of *rabats* alternating with *dieves* and chalk, | 2.85 | 67.80 |
| | 10. *Fortes toises* and limestone, . | 5.95 | 70.65 |
| | 11. Clays, gray, greenish and blue, | 2.10 | 76.60 |
| | 12. Coal strata, | | |

We designate by the term *Ergeron*, a mixture of clay and sand; the *Marlettes* are argillaceous chalk; *Gris*, a mixture of marl and sand; *Rabats* or *Cornus* are the kidney-shaped masses of silex embedded in calcareous marl; some silex has a yellowish orange surface, which has caused it to be called by the workmen *red pebbles; Dieves* is compact clay, of a variable color, but usually blackish; *Fortes toises*, or argillaceous limestone whitish with silex, is more or less compact and impermeable.

The following is a section of the pits of Blaton, situated in the north part of the Couchant de Mons.

| | | | | |
|---|---|---|---|---|
| 1 | Vegetable soil, sand and gravel, | metres | 2 | |
| 2 | White marne, . . . . | | 5 | 2 |
| 3 | Idem bluish, . . . . | | 20 | 7 |
| 4 | *Meule*, . . . . . | | 26 | 27 |
| 5 | Coal strata, . . . . | | | 53 |

The upper part of the strata, called *Meule*, consists of sand and red pebbles, bound together by an argillo-calcareous cement of a bluish or greenish color, in which are scattered blocks of limestone, covered with a great quantity of shells (*peiyres*), oysters, &c. This portion possesses great analogy to the bed called *tourtia*, shown in the next section. The lower portion contains all the elements of the *tourtia*, such as silex and red pebbles, but they are little or not at all aggregated, and are hence deficient in the solidity of these strata, and the great quantity of water they contain renders the sinking of pits very difficult.

33. *Dead strata of the mines of Anzim and Douchy.*

The following is a section of the pits of Cave of Raismes:—

| | | | |
|---|---|---|---|
| Upper cretaceous strata. | 1. Vegetable soil, | 0.80 | |
| | 2. Four *durs bancs de turc*, intervening between five bancs of *turc*, | 8.20 | 0.80 |
| | 3. *Ciel de Marc*, | 11.50 | 9 |
| | 4. *Marle*, | 30.50 | 20.50 |
| | 5. *Gris vert, bonne pierre*, | 10 | 51 |
| | 6. Cornus, | 12 | 61 |
| | 7. 1st blue ferte toise, 2d blue, small bed, 3d blues, 2d small bed, | 18.50 | 78 |
| Lower cretaceous. | 8. Dieves, | 16.50 | 91.50 |
| | 9. Tourtia, | 2.50 | 107.50 |
| | 10. Coal strata, | 2.50 | 110.50 |

The strata called *turc*, which are seven in number in the above section, are a mixture of chalk, clay, and very fine sand. The beds of turc, strictly speaking, are without consistence; but the *durs* beds of turc formed of the same substances are solid, compact, usually thin, and characterized by silex and green (vert) grains disseminated in the mass.

The *Ciel de Marc* constitute the lower portion of the preceding strata; the fracture is rough, and it exhibits a multitude of small grains, green (silicate of iron). This rock is replaced sometimes by blue clay.

The *Marles* are the hard and consistent chalk; some employ it as limestones. The numerous fissures they contain permit the filtration of large springs; however, in the sinking (*foncage*) of the pits of Cave, we meet with only one of any importance.

*Gris*, argilaceous chalk, more fissured than ordinary chalk.

*Vert*, chalk, having a coarse fracture, in which is disseminated a multitude of grains of silicate of iron.

*Bonne pierre*, yellowish limestone, having fine grains.

We call *cornus*, beds of white chalk, in which are scattered (*pyromaques*) silex in pebbles, nodules, or in small grains. Sometimes these silex pieces are so abundant that it seems of itself to constitute the whole layer. At other times they are so rare that

we sink many decimetres without meeting them. It is in this strata, traversed by an infinite number of fissures, that considerable quantities of water are encountered.

The *bleus* are composed of clay, mixed with limestone, and sometimes argillaceous marne, alternating with beds of gray marne much fissured, and called *fortes toises*, first and second bed. These last three always carry more or less water. It happens sometimes that one of them yields no water, and in that case the springs show themselves in other strata, but this circumstance is very rare.

The *dieves*, composed of compact clay, mixed with parts of limestone, are colored green or red. They form a thick bed, impermeable to water, and facilitate the working by restraining the abundant springs of the upper strata from reaching the coal.

Finally, the *tourtia*, a calcareous pudding stone, mixed with clay and quartzose pebble, reposes almost always immediately upon the coal formation. This rock is very tenacious when it does not contain water, otherwise it is dissegregated and without solidity.

The following is a section of the water-carrying strata, traversed by the pits of Naville, called No. 7 of Douchy.

| | | | | |
|---|---|---|---|---|
| 1 | Vegetable soil, . . . . . | metre | | 1 |
| 2 | Marnense clay, . . . . . | | | 0.55 |
| 3 | Cornus, or chalk and silex, . . | | | 15.65 |
| 4 | Beds of blue clay, intervening between layers of gris marne, and arranged as follows :— | | | |
| | False bleus, . . . . . | | 1.30 | |
| | First bleus, . . . . . | | 1 | |
| | Fortes toises, . . . . . | | 2.70 | |
| | Second bleu, . . . . . | | 3.50 | |
| | Small bed, . . . . . | | 0.30 | 15.20 |
| | Third bleu, . . . . . | | 3.10 | |
| | Small bed, . . . . . | | 0.30 | |
| | Fourth bleu, . . . . . | | 1 | |
| | Small bed, . . . . . | | 2 | |
| 5 | Dieves vertes et rouges, . . | | | 40 |
| 6 | Tourtia, . . . . . | | | 1.50 |
| | Coal strata—metres . . . | | | 73.90 |

34. *Thickness of superincumbent cretaceous strata.*

The following is a brief view of the thickness of the superincumbent cretaceous strata of the carboniferous formation of the Couchant du Mons :—

| | | | |
|---|---|---|---|
| Jemmapes, | Société des Pompes, | metres | 79 |
| —— | Haut Flénu, | | 12 |
| —— | Douze actions, | | 130 |
| Quesnes, | Levant du Flenu, No. 18, | | 97 |
| —— | Pompe à feu, | | 47 |
| Quaregnon, | Cossette, No. 10, | | 105 a 106 |
| —— | —— No. 8, | | 75 |

| | | |
|---|---|---|
| Tramenies, | L' agrappe, No. 2, | metres 13 |
| —— | Noir chain, No. 12, | 87 |
| Wasmes, | Hornu et Wasmes, No. 3, | 58 |
| —— | —— —— No. 4, | 105 |
| Grand Hornu, | Puits, No. 1, | 47 a 48 |
| —— | —— No. 10, | 84 |
| —— | —— No. 11, | 74 |
| Elouges, | Grande veine, | 33 |
| —— | Les Andrieux, | 77 |
| Boussu, | Avaleresse du bois de Boussu, | 15 |
| Thulin, | Avaleresse de Thulin, | 26 |
| Dour, | Bellevue, No. 6, | 34 |

The coal formation is seen at the present day, in the bottom of some of the valleys which have been excavated by the action of water; for example, the Grand Vein of Wasmes, and in the midst of the wood of Boussu.

From what has just been said, any one will see that the thickness of the cretaceous strata is very variable, and that there does not exist any determined ratio, according to which the thickness gradually increases or diminishes; the important differences often found between two contiguous localities, justifies the supposition, on the contrary, that the carboniferous formation was exceedingly uneven at the moment when it was covered by the dead strata.

It has been observed that in the extension of the coal zone contained in the department of the North, the cretaceous strata seem to increase in thickness as they advance westward. This observation, however, can be applied only to the whole of the superincumbent strata on a vast extent. The following table contains the thickness of these formations in different localities:—

| | |
|---|---|
| Vieux Condé, | 40 to 47 metres. |
| Fresnes, | 40 to 57 |
| Anzin, | 60 to 75 |
| Abscon, | 108 |
| Aniche and Azincourt, | 95 to 104 |
| Rœux, | 110 |
| Monchy-le-Preux, | 148 |
| Tilloy, | 149 |
| A l'Escarpelle, | 150 |
| Fort de l'Escarpe, | 154 |
| Pommier, | 180 |
| Bienvilliers-au-Bois, | 198 |

35. *Sandy deposits containing springs that intervene between the base of the cretaceous formation and the upper part of the coal strata.*

In some parts of Anzim, the *tourtia* does not rest directly upon the coal strata; but it is separated from it by a deposit of sand, varying in thickness from 1 to 14 inches, and which, in consideration of the vast quantity of water that it contains, has received the appellation of the *torrent.*

These sands, formed of quartz of the size of a bean or pea, and even larger, contain scattered pebbles, hornstone, jasper, and of ferruginous clay, quartz, and other substances, destined to unite in developing beds of tourtia, but still remaining in a state of dissegregation. This strata extends beneath the village of St. Waast, at the south or south-west of the concession of Anzim. On the north-west we cannot exactly determine its limits; on the west it terminates before reaching Kaismes, and on the south-west short of Abscon.

The waters of the *torrent* have no connection with those contained in the cretaceous strata superincumbent on the DIEVES; for in sinking the pits at *La Sentinelle*, the former rose only about 24 metres, while the latter reached a height of 32 metres; so that the level in the sands was about 11.50 metres lower than in the upper beds. Besides the waters of the *torrent* are brackish, and on evaporization they leave a residuum of marine crystallized salt, and differing very little from ordinary salt, whilst those from the upper sources are used in the engines, and do not contain the smallest trace of salt. For a long time the attempt was made to pass this deposit, which was not accomplished until a drain to receive and carry off the water from the sand was made.

The lower dissegregated strata of the bed to which the miners of Blaton have given the name of *meule*, and the thickness of which is about three metres, presents, in all respects, the greatest analogy to the torrent of Anzim. The same is true of the strata penetrated by the pits of St. Alexander, No. 3, and Streppy Braquegnies (centre of Hainaut), containing between the lower portion of the cretaceous and the head of the carboniferous formation, sands of considerable thickness. A section of this covering or upper strata, is as follows:—

| | | | | |
|---|---|---|---|---|
| 1 | Vegetable soil, . . . | metres | 1.50 | |
| 2 | Clay, . . . . | | 9 | 1.50 |
| 3 | Sands, green, afterwards grey, changing to white, . . | | 8 | 10.50 |
| 4 | Rabat, . . . . | | 8.20 | 8.50 |
| 5 | Sands (white afterwards) green, | | 7 | 26.70 |
| 6 | Tourtia, . . . . | | 8 | 33.70 |
| 7 | Greyish clay, . . . | | 1.30 | 41.70 |
| 8 | Quicksands, . . . | | 22. | 4.3 |
| 9 | Coal strata, . . . | | | 65 |

We notice the following particulars respecting these strata:

2. The upper part of the bed of clay is suitable for the manufacture of bricks; but the lower part contains too much sand and gravel.

4. Rabat, composed as we have stated above, (32) presents itself in alternate strata of silex and marne.

6. Tourtia is a pudding stone, composed of marne and silicious pebbles. The mass contains enough of small green grains to give the rock a greenish tint.

7. Is a seam of plastic clay, such as is frequently met with, and often of considerable thickness, in many parts of the surface of the coal basin of Centre.

8. Sands, similar to those of the torrent of Anzim, are very fluid, by reason of the great quantity of water which penetrates them. Their colors are quite variable, being alternately blue, green, white, gray, or black, and the grains are either fine or very coarse. Some beds of plastic clay intervene in the sands. In the midst of the mass is found round pyromaques silex, lenticular white quartz, fragments of silicious pudding stone, sometimes of very large size; lignites to which pyrites adheres; fragments of wood of different sizes, the nature of which is easily distinguished, amber, stiff clay, blocks of limestone, and coal in a great quantity.

A drift of the mine of Louviere, enables us to understand very exactly the sandy strata of that concession. The silicious sands which compose them are mixed with fragments of silex and limestone, forming beds slightly inclined to the horizon, and with a thickness of 15 or 16 metres. Between these beds there intervene seams of impermeable, and often plastic clay, which are 0.05 to 1.50 metre in thickness. This division of the sandy mass into spaces in a high degree permeable, and contained between these tight dams, causes the great difference in the volume of the water of each portion of the strata. The lignites, which are frequently met with, are stratified in beds of 0.05 to 1 metre in thickness, which do not possess any property for restraining the springs.

Sometimes in these localities (Centre du Hainaut) we meet accidentally and at a very great depth, with very thick beds of quicksands; at the instant when the miner, in sinking a pit, strikes them, or even in boring, the sand and water, probably being subject to considerable pressure, gush violently forth, as when an artesian fountain is struck, and rapidly fill the excavation, so that the workmen are obliged to escape quickly. In general these sand formations appear identical, in respect to their composition, nature and consequences, whatever may be the spot in which they are found.

(To be continued.)

## Art. VII. THE AMERICAN MINERS' ASSOCIATION.

The experience of each day proves that in combination is to be found strength and power; that by association for a common purpose and object much can be effected which through isolated action alone could not be accomplished; that from a concentration of facts, and a comparison of views and suggestions, not only an elucidation of many mysteries, but also the most feasible method of surmounting obstacles and difficulties, may arise. Under the view, therefore, of actual benefit to all who are interested in mining affairs, and whose desire is to gain additional information upon the avocation in which they are engaged, I would beg leave to offer the suggestion of the formation of a Mining Association, to be comprised of miners and geologists from the different mining districts of the United States, who would join the association with the intent of imparting their experience to their co-laborers in the great field in which they all are workers.

The advantages to be derived from some well conducted plan of combination, would soon be apparent, by the diffusion of facts and ideas, that for the want of a proper channel, through which to be disseminated, are now lost to the many, and consequently are not producing that favorable result which the true friends of the mining interest of our country are so anxious to witness.

There is no one engaged in mining, who, if possessed of an observing and investigating turn of mind, has not at some period of his operations noticed some fact which has forced itself upon his attention, as worthy of not only further study and research, but of also being made known to others, as a new truth, and consequently one step more in the advancement of knowledge upon this valuable and interesting branch of national industry. The mere expression of this truth, may awaken in the minds of others, a train of thought and inquiry that may lead to important conclusions, or perhaps confirm and make clear, some correlative fact which else would have been enshrouded in doubt and uncertainty. Where would be a more fitting place to promulgate such facts, than in an association of men, whose daily exertions would cause them to appreciate the value of such communications, or whose experience would lead to an impartial investigation of the fact presented, and thus establish its claim to validity and consequent attention.

In our country the study and practical working of mining, are comparatively in their infancy. If any advancement is to be made in this path, it must be accomplished by carefully studying the phenomena attendant upon the disposition of the various ores in the veins from which they are extracted, and of cautiously determining the most effectual method of attaining the desired results. In a field so diversified, the experience of any one *individual,* could not by any possibility reach all the exigencies

of the case. In a field so extended, the experience of any one individual could not under ordinary circumstances be rendered efficacious to others. Through the medium of association, a valuable accumulation and arrangement of truths could be maintained, and each individual derive a benefit from the experience of all. A mutual interchange of sentiments and thoughts, upon topics of interest to all, would be productive of good feeling, harmony, and profit.

By forming an Association which should hold its annual meetings in some one of the cities, where the business of the mining men would necessarily call them, a double object might be accomplished by the members of the association; as they could have ample time to make their required purchases and give all the hours to the association that it would demand. Each State, or each mining district, could form branch associations which could meet as often as desirable, and delegates from which could be sent to the annual meeting of the association. Specimens of the vein stone, ore, and wall rocks of each section, from various depths below the surface, could be brought to the yearly convocation, and which, if carefully preserved and correctly labelled, would by the accumulations of a few years, not only produce a good mining cabinet, but also afford to the geologist a practical view of all sections of the country. Plans and models of mining machinery and implements, could thus be brought together; and by the concentration of so varied and rich a fund of practical information, the rooms of the association would soon claim wide attention as the best school for mines that our country can afford. I deem this subject one of the utmost importance, to those connected with the mining interest, and believe that if carried into execution, it cannot fail to be productive of highly valuable results. I have not treated the subject at that full extent in this suggestion, that it is worthy of receiving, but have merely cast my bread upon the waters hoping to find it ere many days. I believe that the suggestion will meet with a favorable response from all true lovers of the science of mining, and in sincere good feeling, ask for an expression of views, from all who feel interested sufficiently in the matter, to deem it worthy of their co-operation. It would be well for all who reply, to state at what time they could most conveniently be present at the organization of such an association, which, to give ample time to all to consummate their arrangements, perhaps should not be earlier than September next; still let each one who replies, name the time most consonant with his views, and the expression of the majority shall be the criterion by which to fix the date of meeting; due notice of which, will be sent to each correspondent by mail, and be published in the "*Mining Magazine.*" All replies should be addressed to this office.

S. P. L.

## COMMERCIAL ASPECT OF THE MINING INTEREST.

New York, April, 1856.

THERE has been rather more activity in Mining stocks since our last issue. The stocks actively dealt in at the Mining board, are now the North Carolina Co., Ward Coal and Iron Co., Gardiner Gold Co., and Franklinite Steel Co. The North Carolina Co. has recently revived and is in quick demand at $1.75 per share; the company we learn are doing a large business, selling to the Boston refiners, and are now engaged in building smelting works on their lands for smelting all their ores; the economy which will ensue therefrom will add largely to their profits. The saving in transportation alone being a considerable sum. Gardiner Gold Co. stock is selling at $1.00 to $1.25 per share. There seems to be a "Bull and a Bear" interest in this stock, as both sales are made at buyers' and sellers' option, the one for an advance, the other for a decline. A few hundred shares of McCulloch Gold Co. have been sold as low as 5s. per share; this stock is much depressed. There has been some movement in the Aberdeen Co's. shares, which have fluctuated in value considerably and have been selling at 15s. per share.

The Ward Coal Co. has risen from 32 (at which it was selling at our last report) to 46½ per cent; this stock is not called at the regular board of Brokers, but is only offered at the Mining board.

We learn that the American Coal Mining Co. is progressing very favorably; it has opened a depot at Jersey City, joining the Cunard Steamship Co's. dock. Its coal is being largely used by the ocean steamers and by the ferry companies for steam purposes. On the payment of the last installment the Trust will be closed and the stock will then assume a fixed and regular position. Many of the stockholders are anticipating the time of paying the last installment, and if all were to do so the Trust would be closed immediately.

The meeting of the stockholders of the Conrad Hill Gold Co. is about to be held and propositions will be made for a resumption of work by small assessments on the stockholders.

The President of the Neuvitas Copper Co. of Cuba has called a meeting of the stockholders for the purpose of winding the company up by selling its property, in case they do not consent to make advances for the further prosecution of the works, which the leading stockholders do not seem disposed to do.

The stock of the Delaware and Hudson Canal Co. has advanced to 129¾ and is still rising, and that of the Pennsylvania Coal Co. to 101¼; Cumberland Coal Co. is steady at 23¼, and Reading is active at 92½. The Copper Companies of Lake Superior have been very inactive as regards the sale of stock. Minnesota and Cliff are the only two companies whose stocks are at present productive. There has been some inquiry for the stock of the Hiwassie Co. of Tennessee, but there is apparently none in the market for sale. The other Tennessee companies are quiet.

The state of the money market is favorable for new enterprises did the proper spirit exist; two or three new companies will appear shortly before the public. The approaching peace in Europe will give a rebound to trade the world over. The change from a non-productive employment of large masses of men as armies, to a productive employment in works of industry must work favorably for all interests.

*The Grass Valley Quartz Mining Company*, located in Grass Valley, Nevada County, California, has proved to be one of the most successful quartz mining companies in that State. The company is working under a small capital of $250,000—and the mine is extensively opened and equipped. It has also yielded large amounts of gold thus far in the progress of the works, and its promise for the future justifies the most sanguine expectations. Under the head of "Gold Mining Operations," in this number of the Magazine, will be found an extensive description of the present state of the mine. The company owns a large mining property in Grass Valley, comprising some of the best claims in that region.

An accumulation of money in London and Paris, especially London, must take place as soon as the armies at present in the East are drawn home, and a consequent decline in the rate of interest will ensue. This has an intimate relation with the state of our money market in New York, as, any serious fall in the rates of interest in Europe always leads to a large increase of foreign capital employed here both in temporary and permanent investments.

The rates for the use of money in loan and discount are 6 to 7 per cent. Sterling exchange is heavy at 109¾. The receipts and exports of cotton are unusually large this season, and at high prices. It is estimated that the receipts of cotton at market this season will reach between 3,500,000 to 3,600,000 bales, a very large increase. Prices of all kinds of produce are high and remunerative, and the basis of wealth throughout the country has been immeasurably extended since last harvest.

The following is an analysis of silica, of which there are large quantities on the line of the railroad from the Breckenridge coal mines to the river It is of an excellent quality for glass manufacture.

| | |
|---|---|
| Silica, | 99 63 |
| Alumina, | ·27 |
| Iron, | ·10 |
| | 100 |

# COALS AND COLLIERIES.

## ANTHRACITE COAL TRADE FOR 1855.

| | |
|---|---|
| Shipments by Reading Railroad to April 3d, . . . . . | 415,461,18 tons. |
| Same time last year, . . . . . | 508,759,12 " |
| Decrease, . . . . . : | 93,287,14 " |

## CUMBERLAND COAL TRADE.

For the year to March 29th, . . . . . 59,299,17 tons.

## PRICES OF ANTHRACITE.

The price of anthracite, by shippers, is thus noticed by the Pottsville Journal:—

Coal *must* command a fair remunerating price this year, in spite of all *croaking purchasers* below, who are already beginning to sing to "the same old tune," that the demand is dull. Any operator, who after the trade opens, sells merchantable coal to Richmond for less than $2 00 *a* $2 12½ for white ash, and $2 25 *a* $2 37½ for red ash, according to quality (for the Richmond purchaser always requires a pretty large slice of the profits), and $2 25 for white and $2 50 for red ash, by canal, ought to give up the business at once, and acknowledge that he is incompetent to carry it on. We are not the advocate for high rates, as every reader of the *Journal* knows, but the prices named are fair; if any thing a shade below what they ought to be to pay in all departments; and any dealer below, who tries to force prices below these rates, in the present state of the trade, ought to be looked upon and *treated as an enemy to the trade and the region, and unworthy the confidence of fair and honorable business men.*

## DELAWARE AND HUDSON CANAL COMPANY'S REPORT.

In accordance with past usage, the Board of Managers submit to the Stockholders a statement of the business of the year 1855, terminating on the 1st of March, on reference to which it will be found that the net profits of the company amount to $1,298,895 38, being a fraction over 18 per cent. on the capital stock.

The canal was opened at the usual period in the spring, and there were transported on it during the season of navigation, by this company, 565,376 tons of coal, including 26,765 tons frozen up in the canal in the winter of 1854. The quantity transported by the Pennsylvania Coal Co., during the same time, was 528,070 tons, including 31,566 detained on the line of the canal during the winter by the above cause.

The amount of miscellaneous traffic on the canal is shown by a statement herewith submitted.

The aggregate amount of toll received during the year on the canal and railroad, was $652,362.94.

The extraordinary severity of the winter has somewhat retarded the usual annual repairs on railroad and canal; but thus far no injury has occurred to the company's works, and it is hoped that the canal will be ready for navigation at about the usual time, when the business of the company will be resumed with energy and vigor.

The Board see no reason to doubt the continued prosperity of the company.

By order of the Board,

JOHN WURTS, *Pres't.*

*New York*, March 25th, 1856.

*Statement of the Business of the Delaware and Hudson Canal Company, for the year ending March 1, 1856.*

| Dr. | | | Cr. | |
|---|---|---|---|---|
| To coal on hand March 1, 1855. | $184,092 00 | | By sales of coal to March 1, 1856 | 1,844,485 49 |
| Purchased | 23,500 61 | | Canal and railroad tolls collected | 652,362 94 |
| | | 207,592 61 | Barge profits | 7,962 15 |
| Mining coal | | 382,935 43 | Coal on hand at Honesdale, Weymart, Rondout and New York | 801,881 00 |
| Railroad transportation and repairs | | 313,867 08 | | $3,306,691 58 |
| Canal repairs and superintendence | | 253,390 69 | Balance | 1,298,895 38 |
| Freight of coal to Rondout | | 572,876 58 | | |
| Labor and expenses at Rondout | | 63,002 07 | | |
| Rent, salaries, current expenses, &c. New York office | | 32,862 79 | | |
| Coal yard and harbor expenses, taxes, interest, &c. | | 134,359 08 | | |
| Depreciation account | | 47,399 92 | | |
| Balance | | 1,298,895 38 | | |
| | | $3,306,691 58 | | |

ISAAC N. SEYMOUR, *Treasurer.*

By the above it would appear that the company mined the 565,376 tons at the rate of 8 cents per ton—the transportation across the mountain and repairs, was equal to 50 cents per ton—the freight from Carbondale to Rondout averaged $1 01¼ per ton, and the freight from Rondout to New York was 28 cents per ton. The expenses at Rondout for transhipment, &c., was equal to 12½ cents per ton on the whole quantity. The company appears to have a large stock of coal on hand, March 1, 1856, compared with the supply on hand, March 1, 1855.

The following table exhibits a very rapid increase in the receipts of tolls for the last ten years, four fifths of which is derived from the coal transported over their works by the Pennsylvania Coal Company. This trade secures the stockholders fat dividends.

*Statement of Tolls received on the Delaware and Hudson Canal and Railroad for the last ten years.*

| | | | | | |
|---|---|---|---|---|---|
| 1846 | 26,068 65 | | 1851 | 158,441 96 | |
| 1847 | 88,971 84 | | 1852 | 298,174 67 | |
| 1848 | 46,548 54 | | 1853 | 378,479 88 | |
| 1849 | 84,817 95 | | 1854 | 567,849 52 | |
| 1850 | 97,999 15 | | 1855 | 652,362 94 | |

*Officers of the Delaware and Hudson Canal Company, for* 1856.

*Managers:*

John Wurts, Wm. M. Halsted, Silas Holmes, Jacob R. Le Roy, Wm. S. Herriman, Charles N. Talbot, Lora Nash, Edward J. Woolsey, William Musgrave, Geo. T. Olyphant, Daniel B. Fearing, Robert Ray, Daniel Parish.

*President:*
JOHN WURTS.

WILLIAM MUSGRAVE, *Vice President.*

Isaac N. Seymour, *Treasurer.*
James C. Hartt, *Secretary.*

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INFLUENCE OF GRADES ON ROADS TRANSPORTING COAL, AND THE ROUTES FROM THE ANTHRACITE REGION.

This subject is noticed extensively in a Report of Mr. J. Dutton Steele to the Reading Railroad Company. The object of this report is to compare the various railroad routes to market from the Anthracite Region. So much as relates to the influence of grades or the cost of transportation is of universal interest. But as the statements respecting the various routes are more com-

plete and accurate than have been before published; we shall insert the entire report in the present and next number of this Magazine.

POTTSTOWN, PA., *Dec.* 28, 1855.

JOHN TUCKER, Esq., *Pres. Philad. and Reading R. R. Co.*

DEAR SIR: I herewith respectfully submit a map and profiles of the canals and railways by which coal is transported from the several anthracite coal fields to the sea-board. The data used in their compilation have been collected chiefly from the offices of the companies or their published reports, and if error exists, either in lines, grades or distances, it may be ascribed to a want of perfection in the records, or to some unintentional oversight on the part of the compiler. There has been no object in view except that of obtaining a correct description of these important improvements, and it is believed that no previous connected view of them has equal claims to accuracy.

In indicating the prominent features of these works, and comparing their capability for cheap and extended transportation, some point should be selected as a common termination; they will, therefore, be considered as resting with one end on the city of New York, and the other at the chief shipping points of the coal basins which they are intended to drain. Mount Carbon, Mauch Chunk, Scranton and Carbondale, are the points from which distances will be estimated: and the important markets for this mineral, passed in several cases on the way to that city, may for the present be overlooked.

The following is a general description of the several routes:—

*By way of Lehigh Valley and Belvidere Delaware Railroads.*—Commencing at Mauch Chunk, this route descends the Lehigh valley by railroad, with grades in the direction of the trade to South Easton; the gauge is 4 feet 8½ inches, and the grades do not generally exceed 22 feet per mile, with a curvature limited to 800 feet radius; but on the 2½ miles at the west end of the road there are grades of 36 feet per mile, and a curve of 358 feet radius. From South Easton it descends the valley of the Delaware by the Belvidere Delaware Railroad, to the summit level of the Delaware and Raritan Canal at Trenton, thence by canal and bay navigation to New York. The gauge of the Belvidere Delaware Railroad is 4 feet 10 inches, and its grades all in the direction of the trade; they do not generally exceed 16 feet per mile, or the curvature 1,274 feet radius; but at the upper end they reach 35 feet per mile, and there is a curve of 450 feet radius. This route is intended to work in connection with the Delaware and Raritan Canal, and suitable wharves are constructing at Trenton for the transfer of coal from cars to boats with as little delay to either as possible. It is expected that they will be ready for use soon after the opening of navigation this spring.

The distances are as follows:—

| | |
|---|---|
| From Mauch Chunk to Easton | 45 miles. |
| " Easton to Trenton | 50 " |
| Total by rail | 95 " |
| " Trenton to New Brunswick, by canal | 37½ " |
| " New Brunswick to New York, by river and bay navigation | 34 " |
| Total | 166½ |

It will be observed that the railroad portion of this route has a variation of gauge of 1½ inch, and a change of motive power at Easton; the former it is proposed to overcome by an increased width in the tread of the car wheels.

*By way of the Lehigh Valley and New Jersey Central Rail Roads.*—The Lehigh valley portion of this route has already been described. From Easton the New Jersey Central Railroad reaches across the State, from which it derives its name, to Elizabethport, on the Bay of New York, where the construction of wharves suitable for loading sea-going vessels has been commenced; but the eastern terminus of this avenue seems as yet but indefinitely deter-

mined upon, as Perth Amboy and a point on Newark Bay are talked of in connection with it. This road was opened for general traffic in July, 1852, to Easton, and, simultaneously with the progress of the Lehigh valley road, its proprietors have been looking to the coal trade as a source of enlarged business and revenue. With this view they are now engaged in reducing its eastward grades to 22 feet per mile, and preparing for a second track; it is undulating in its character throughout, and, when the improvements now in progress are completed, its extreme eastward grades will be 22 to 23 feet per mile, and its extreme westward grades 50 feet per mile, with a minimum radius of curvature of 1,432 foot. Its gauge is 4 feet 8½ inches, but as an important feeder will join it at New Hampton, 15¾ miles from Easton, with a gauge of 6 feet, preparations are making to lay down a third rail, that it may be enabled to accommodate the cars from the Lehigh valley, and also those from the Delaware, Lackawanna, and Western Roads.

It will thus be seen that the New Jersey Central seeks to be one of the grand trunks for the transit of coal. It has entered the list for a portion of the Lehigh valley trade, and will be the only outlet for the Delaware, Lackawanna, and Western, and it will have two tracks of three rails each for three fourths of its length. On the 31st of October last a coal train reached it from the Lehigh valley, and was passed to Elizabethport; and since that time some two small trains a week have been carried over it, until the 1st of December, when this operation was suspended for the winter, to allow of a better connection being made with the Beaver Meadow Railroad at Mauch Chunk. In this connection, I may mention two feeders which are in contemplation to the Lehigh valley, and which will be indirectly feeders to this road.

The first is a connection between Tamaqua and Weissport, a point on the Lehigh, 4 miles below Mauch Chunk, by the valley of Mahoning. This contemplated branch is 17 miles long; its grades descend in the direction of the trade at a rate not exceeding 50 feet per mile; its curvature will have a limit of about 600 feet radius, and its construction is contemplated by the Lehigh Valley Company.

The second is the Allentown Rail Road, which is projected, with undulating grades, from Auburn (the junction of the Dauphin and Susquehanna Rail Road with the Reading) to Allentown, on the Lehigh. It is estimated at from 38 to 40 miles long, with eastward grades of 20 or 22 feet, and westward of 32 feet per mile. More careful surveys are now making of this link.

The distances from Mauch Chunk are as follows, viz:—

| | |
|---|---|
| From Mauch Chunk to Easton, by rail | 45¼ miles. |
| " Easton to Elizabethport | 68¼ " |
| " Elizabethport to New York, by bay navigation | 12 " |
| Total | 121¼ " |
| From Tamaqua to Weissport, by rail | 17 miles. |
| " Weissport to Easton | 41¼ " |
| " Easton to Elizabethport | 68¼ " |
| " Elizabethport to New York, by bay navigation | 12 " |
| Total | 134¼ " |
| From Mount Carbon to Auburn, by rail | 10 miles. |
| " Auburn to Allentown " | 38 " |
| " Allentown to Easton " | 16¼ " |
| " Easton to Elizabethport " | 68¼ " |
| " Elizabethport to New York, by bay navigation | 12 " |
| Total | 139¼ " |

It will be observed that this route, with its contemplated westward branches, will have a change of motive power at Easton.

*By way of the Delaware, Lackawanna, and Western Road, and the New Jersey Central.*—The New Jersey Central portion of this route has already been described. The Delaware, Lackawanna, and Western is composed of two roads, which however, will probably be worked in conjunction, the first, or Pennsylvania section, reaching from Scranton to the Delaware, and the Warren Railroad, in New Jersey, connecting thence with the Central Road at New Hampton.

Starting at Scranton, a commanding point in the Wyoming coal basin, this route ascends at the rate of $75\frac{2}{10}$ feet per mile for five miles, and, after a short level, continues its ascent for thirteen miles at the rate of $54\frac{5}{10}$ feet per mile; the next nine miles are undulating, with eastward grades of $25\frac{1}{4}$ feet, and westward of $51\frac{1}{2}$ feet per mile; after which the regular descent to the Delaware commences, which is chiefly effected by grades of 77 feet per mile, in a distance of $27\frac{1}{2}$ miles; thence to the crossing of the Delaware, the line is undulating for nearly eight miles, with grades of $16\frac{1}{2}$ feet against, and $20\frac{2}{5}$ feet in favor of the trade. After crossing the Delaware, we are on the Warren Railroad, the first $9\frac{1}{2}$ miles of which has grades against the trade of $21\frac{7}{10}$ feet per mile; and the next five miles, passing what is locally called the Switch, has grades eastward of $55\frac{3}{10}$ and westward of $88\frac{8}{10}$ feet per mile; but the latter it is intended ultimately to reduce, and also to save two miles of distance by a tunnel three thousand feet in length, which it is estimated will not be finished much before the year 1860. The remaining seven miles of this road undulates at the rate of $23\frac{7}{10}$ feet eastward, and 54 feet westward per mile, running up, however, in particular cases, according to the notes we have, to $33\frac{7}{10}$ and $69\frac{5}{10}$ feet per mile. The minimum radius of curvature is 800 feet, but the roads are quite crooked, having 6,803 degrees of curvature on $84\frac{7}{10}$ miles, or upwards of 80 degrees per mile.

It it intended that this Delaware, Lackawanna, and Western portion of the route shall ultimately resolve itself into a road with no grades eastward of more than 22 or 23 feet per mile, except at its west end, where it will continue to have five miles of 75 feet, and thirteen miles of $55\frac{1}{2}$ feet per mile to overcome: and until the completion of the tunnel on the Warren Rail Road, assistant power will also be employed at that point; the early part of the summer of 1856 will probably see it open for business. Its gauge is six feet, and it will have at least one change of motive power; a feeder (the Lackawanna Railroad), which is intended to intersect it five miles from Scranton, will make its capacity equal to that due a road with grades of $55\frac{1}{2}$ feet per mile against the trade.

The distances from Scranton are as follows, viz:—

| | |
|---|---|
| From Scranton to New Hampton, by rail | $83\frac{1}{4}$ miles. |
| " New Hampton to Elizabethport | $47\frac{1}{4}$ " |
| " Elizabethport to New York, by bay | 18 " |
| Total | $148\frac{1}{4}$ |

This road has an important westward extension to the New York and Erie Rail Road at Great Bend, a distance of $47\frac{8}{10}$ miles; it was opened for business in 1851, and efforts were immediately made by its enterprising proprietors towards the introduction of anthracite coal into Western New York, which have resulted in the following westward movement of this mineral from Scranton to Great Bend, along their road, viz:—

| | |
|---|---|
| In 1851 | 6,000 tons. |
| 1852 | 67,487 " |
| 1853 | 97,358 " |
| 1854 | 133,964 " |
| 1855 (about) | 200,000 " |

It will be observed that this new feature in the coal trade has been growing since 1852 at the rate of about forty per cent. per annum, and, on the successful opening of the North Branch Canal, is destined to realize a large increase and great future. I am not advised of the grades against the western

trade of this extension, but, from the working of the road, judge them to be 50 or 55 feet per mile.

The Railroads above described constitute the *new* channels for coal traffic which are about to be brought into use. It will be observed that they resolve themselves into two routes, the one by the New Jersey Central Railroad to one or more points on New York Bay, and the other by the Belvidere Delaware Railroad to Trenton, and thence by Delaware and Raritan Canal. Their horizontal projection on the map looks quite formidable, extending from Dauphin, the southern extremity, to Carbondale, at the northern end of the Wyoming Basin, and commanding at their eastern termini an important market. Before considering their powers, I will describe the several other avenues for this great trade with which they will divide the business.

*By way of the Philadelphia and Reading Railroad.*—Starting from Mount Carbon, this route descends the valley of the Schuylkill to Port Richmond, on the Delaware; thence by the Delaware and Raritan Canal, and adjacent river and bay navigation, or by sailing vessels or steam barges round Cape May to New York. The railroad portion of this route has a gauge of 4 feet 8½ inches, and its grades descend in the direction of the trade except $1\frac{7}{16}$ mile in passing the summit between the Schuylkill and Delaware, on which distance there is an extreme grade of $88\frac{4}{10}$ feet per mile against the trade. Two assistant engines are used to help the trains at this point, and its favorable position, and short distance, prevent its limiting, in any way, the capacity of the road. The general grades do not exceed 17½ feet per mile, or the curves 800 feet radius; but at the west end they reach, for a short distance, 28½ feet per mile, and there is a curve of 600 feet radius. The distances are as follows, viz:—

| | |
|---|---|
| From Mount Carbon to Richmond, by rail | 93½ miles. |
| " Richmond to Bordentown, by river | 25½ " |
| " Bordentown to New Brunswick, by canal | 43½ " |
| " New Brunswick to New York, by river and bay navigation | 34 " |
| Total | 196½ " |

The railroad portion of this route is 1¾ miles less than by way of Lehigh Valley and Belvidere Delaware, and it is without variation of gauge, or change of motive power. It has six miles more of canal, and 25½ miles more of river navigation, and $1\frac{7}{16}$ miles of grade against the trade, is in full tide of successful operation, and carries double the quantity of coal to the seaboard of any other avenue.

*By way of the Schuylkill Navigation.*—This work is partly canal, and partly slack-water navigation, and extends from port Carbon down the valley from which it derives its name, to Philadelphia. Its entire length is 108 miles, and its lockage 620 feet. The distances are as follows, viz:—

| | | |
|---|---|---|
| From Mount Carbon to Philadelphia, by canal | | 106½ miles. |
| " Philadelphia to New York by Delaware and Raritan canal | 43½ | |
| Bay and river navigation | 77 | |
| | | 120½ " |
| Total | | 226½ " |

This work has an increasing business; its coal tonnage in 1855 has reached 1,105,263 tons, and we may look to its being swelled up to 1,500,000 tons, within the next five years.

*By way of the Lehigh Navigation, and Delaware Division of the Pennsylvania Canal.*—The Lehigh portion of this route is chiefly slack-water navigation, whilst the Delaware portion is entirely canal; the lockage is 525 feet, and the distance from Mauch Chunk as follows, viz:—

| | | |
|---|---|---|
| From Mauch Chunk to Easton, by canal | | 46½ miles. |
| " Easton to Bristol, " | | 59½ " |
| " Bristol to New York, " | 43½ miles. | |
| Bay and river navigation " | 43½ " | |
| | | 87 " |
| Total | | 193½ " |

A saving of 25½ miles of distance to New York may be effected by the use of the feeder of the Delaware and Raritan Canal from Lambertsville to Trenton, and also 40 feet of lockage.

To Philadelphia the distances by these canals are as follows:—

| | | |
|---|---|---|
| From Mount Carbon to Philadelphia, by canal | 106¼ | miles. |
| river | 1 | " |
| | 107¼ | " |
| From Mauch Chunk to Philadelphia, by way of L. & D. Canal | 106¼ | miles. |
| river | 17 | " |
| | 123¼ | " |

The coal tonnage on the Lehigh has reached 1,233,905 tons in the present year, and it, like the Schuylkill Canal, may be expected to reach 1,500,000 tons in a few years. In this connection I may mention the Morris Canal, one of the outlets from the Lehigh, which stretches across New Jersey from Easton to a point on the Passaic River, 11 miles from New York. Its length is 90¼ miles, and its total rise and fall is 1,674 feet, which is overcome by 23 inclined planes and 25 locks. 301,709 tons of coal have been entered on this canal during the year 1855, which is the largest quantity it has ever reached. Its capacity is estimated by its friends at 500,000 tons, which is believed to be the ultimate annual capacity of inclined planes working in connection with canal navigation.

*By way of the Delaware and Hudson Canal.*—Starting from Carbondale, near the north end of the Wyoming coal basin, this route passes by an inclined plane and gravity rail road 15¼ miles to Honesdale, the head of the Delaware and Hudson Canal, and thence by canal 108 miles to Rondout, on the Hudson River, 85½ miles above New York. The railroad portion of this route has 14 inclined planes, which overcome conjointly an elevation of 2,123 feet, with intermediate roads of sufficient grade to enable the cars to move by gravity, and thus allow of the motive power being concentrated in the stationary engines which work the planes. A mountain, which separates the Wyoming basin from the drainage towards the eastern seaboard, of 900 to 1,000 feet in height above the coal, has induced the adoption of this system of rail roads in the northern part of the anthracite region. There is no necessary connection between the loaded and light car tracks; indeed they are generally distinct roads, and, in some cases, as much as a mile apart. The canal portion of this route has a lockage of 1,126 feet. Its distances from Carbondale are as follows, viz:—

| | | |
|---|---|---|
| From Carbondale to Honesdale, by rail | 15¼ | miles. |
| " Honesdale to Rondout, by canal | 108¼ | " |
| " Rondout to New York, by river | 85½ | " |
| Total | 208¼ | " |

A variation of this route is by the Pennsylvania Coal Company's Washington Railroad from Pittston, a central point in the Wyoming basin, to Hawley on the Delaware and Hudson Canal, 8 miles east of Honesdale. This is also an inclined plane and gravity road of 45 miles in length, on which there are 22 planes, and the net elevation overcome by them is 2,550 feet. We are unable to procure the necessary notes for a profile from the office of the Company, which will account for its not being found upon the map with the other works. The distance from Pittston is as follows, viz:—

| | | |
|---|---|---|
| From Pittston to Hawley, by rail | 45 | miles. |
| " Hawley to Rondout, by canal | 100 | " |
| " Rondout to New York, by river | 85½ | " |
| Total | 230½ | " |

Since 1848, the Delaware and Hudson Canal Company's Rail Road has done a business ranging from 437,500 to 500,000 tons; and, since 1852, that

of the Pennsylvania Coal Company's road has ranged from 426,164, to 500,000 tons. In the year 1855, the former has transported 528,000, and the latter 564,000 tons of coal, which are the largest quantities ever reached by either of these works. The estimated capacity of works of this character is 700,000 tons; but their steady workings, in connection with canal navigation, at about 500,000 tons, indicates that the estimate is not likely to be reached in practice; that these two railroads, as well as the Delaware and Hudson Canal, have about reached their ultimate capacity in coal transportation, and that we may hereafter look to a continuous annual stream of this mineral along the route under view of from 1,000,000 to 1,200,000 tons. Such seems also the view of the Pennsylvania Coal Company, as they are now engaged in projecting a new railroad route across the country from Pittston to New York, a distance of about 140 miles. The country over which this proposed road will pass, loses none of the difficulties which govern the features of the present works of that Company; it also will be an inclined plane and gravity road with some 36 planes; a portion of it on the New York end, however, it is proposed to work with locomotives. Working over the same rugged country, and on the same principle with their present road, the same rule will govern its powers, except that it will have the advantage of being able to work in the winter, which may swell its ultimate capacity to 700,000 tons per annum.

Such are the main trunks for conducting anthracite coal to the seaboard. In 1856, there will be in active operation about 360 miles of canal and 470 miles of railroad engaged in this trade, besides the works on the Susquehanna and westward, and the numerous branches which ramify through the coal fields.

To be continued.

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### COAL FOR LOCOMOTIVES.

The use of coal in locomotives is exciting considerable interest in parts of the country at the South and West, where coal is found contiguous to railroads. We shall present all that has appeared on the subject from the first. The Engineer and Superintendent of the Reading Road, Mr. G. A. Nicolls, in a late report states these facts:—

Since 1847, our coal trade has been carried on entirely by engines of the largest class, weighing from 24 to 28 tons with water and fuel; and with an annually increasing proportion of their number using anthracite coal exclusively. In 1847, 5 per cent. of our coal transportation was hauled by engines using the latter fuel; and in 1854 this proportion had increased to 85 per cent. This company has now in use, 52 first class locomotives, using and built expressly for this description of fuel! 49 for coal and 3 for passenger trains.

All use anthracite coal with complete success, in their trip of 95 miles down and up the road. The distinctive features of these engines, adapting them to the use of this fuel, are as follows:

1. A large, and very long (from 5 to 7 feet) fire-box.
2. No water way in back part of fire-box; that portion of the latter being occupied by doors, and an open grate for the convenience of raking the fire, breaking "slag," "clinker," &c.
3. A "dead grate bar," fitting closely to the inside of the fire-box, and extending 4 to 10 inches therefrom, to prevent the rush of air upwards impinging upon, and injuring the lower sheets of the fire-box.
4. A variable exhaust, controlled by the engineer.
5. An opening smoke stack, protected on top only by a strong cast-iron grating.
6. Iron tubes, and wide water ways.
6. A water tight ash pan, holding one or two inches of water, to keep the under surface of grate bars cool.

*Comparing Coal and Wood as Locomotive Fuel.*—Engines using anthracite

coal, cost from 10 to 20 per cent. more for repairs, than those using wood, caused mainly by the greater wear of their boilers and fire-boxes—the latter requiring renewal of its lower sheets every 18 to 24 months when doing heavy duty. One ton (2,240 lbs.) of good, pure, free burning anthracite, will be equal in a locomotive to about 1½ cords of good dry oak wood. If the latter be green, or inferior in quality, or if ordinary pine wood be used, the difference will be still greater—in favor of the coal.

Our coal-burning engines haul, during the busiest season, an average of 100 coal cars 95 miles to market, loaded with 490 tons of coal; returning the same distance the following day with the empty cars. The loaded train weighs, exclusive of engine or tender, 740 tons, and the empty train returned, 250 tons, all of 2,240 lbs.

The total fall from Port Carbon to tide water is about 600 feet, divided into various grades, generally very light, none exceeding 19 feet between Schuylkill Haven and Falls—the points where trains are made up, and divided between Richmond and Philadelphia.

There is no rising grade between Port Carbon and Richmond, with the exception of one of 44 feet at the Falls—for 1½ miles, up which assistant power is used, pushing the trains behind, the leading engine exerting her full power also. Forty miles are level, 8¼ miles of which are at one point continuous.

In performing this duty, our engines in good order, and with carefully selected anthracite coal, will consume between 8 and 9 tons of that fuel in the round trip of 190 miles, and haul their trains through as fast as limited by the rules of the road—from 10 to 12 miles per hour; with the power of attaining a higher rate of speed if allowed.

The average quantity of fuel used per trip during the whole year, is necessarily larger as stated in the annual reports—owing to the coal used in kindling being included—as well as that lost by broken trips, snow and sleet storms, waiting and laying over for trains, delays and accidents, &c., which railroad men can readily comprehend.

Such are the results of using this fuel in our heavy coal transportation.

Those passenger engines consuming it exclusively, haul 6 eight-wheeled passenger cars 93 miles, between Pottsville and Philadelphia, at speeds of 30 miles per hour, on a level, with a consumption of about 2¼ tons down, and 2¾ up the road.

In no case, with good coal and ordinary care, is any practical difficulty experienced in keeping up the coal fire, and a proper supply of steam, for either the transportation of coal and heavy freight, or passenger trains.

We prefer coal fuel to wood for several reasons, and should not return to the latter, even if used at the same cost.

Anthracite coal fuel secures us a considerable saving in expense compared with wood.

The supply of the former may be considered inexhaustible, when the latter is becoming more scarce and costly annually.

Wood requires about five times the storage space of coal, and cannot be handled and loaded as promptly and cheaply as the latter, which may be dumped into the tender.

Coal fire is proof against all casualties of sparks, cinders, &c. Coal requires no seasoning, being best adapted for use immediately on being mined. For fast passenger and express trains, requiring long runs with few stoppages, coal is particularly suitable. It occupies only one fifth the space, and is equal in effect to double the weight of wood doing the same duty.

### ANTHRACITE COAL FOR LOCOMOTIVES.

Another view of the case is presented in the annexed statement.

The use of anthracite coal for locomotives was first commenced on roads commanding a cheap and abundant supply of that fuel. This was, and is

still, especially the case with the Reading railroad, where anthracite is how used for more than three-fourths of the great transportation upon that work.

Under such circumstances, the practicability of employing anthracite in locomotives became an important object of attention and study. It was especially an object to discover the best means of preserving thefurnace and tubes from the destructive action of the coal; and still more to secure a constant and active fire throughout long trips. Considerable changes were therefore made in the construction of engines, to secure the necessary means of controlling the fire, including the regulation of the draught, the separation of slag and cinder from the burning coal, and the uniform admission of air to all parts of the surface of the fire.

So long as anthracite could be burned on railroads directly within the coal region, without gross waste and without excessive destruction of the engines, it was obviously much cheaper than wood.

The result of the experience upon the Reading railroad shows, as would have been supposed, that coal is the cheapest fuel for the purposes of that road. It is burned without difficulty, upon long trips and with heavy trains.

The material and construction of the furnaces have been adapted to its use, until the excess of repairs due to its influence, is but moderate.

It must be remembered, however, that the cost of wood upon this road, is taken at about five dollars a cord, in the comparison of the relative economy of the two fuels. And at the same time, none of the wood-burning engines are of equal size to the coal-burners, and cannot consequently, without reference to the kind of fuel used, perform the same service. It is found by observation that the consumption of fuel, in engines of different dimensions, is not in the same proportion as the difference in their power. With two engines, one having twice the tractive power of the other, the larger would use probably not over 60 per cent. more fuel than the other engine, of half the power. This is owing to the fact that the sources of waste, by imperfect combustion, by radiation, by the admission of cold air in firing and other similar causes, are equally numerous and nearly as influential in the small as in the large engine.

If the wood-burning engines on the Reading road were of the same dimensions as the coal engines, the difference in their expenses for a given standard of work done, would probably be less than it now is.

In other situations where wood might be as cheap or cheaper, but where coal would be much dearer than on the Reading road, the use of coal, as now practised, might prove more expensive than wood for the same business. With ordinary trains, subject to frequent delays and interruptions, the loss of coal thereby occasioned would also be relatively greater than the loss with wood. It is generally known that not only the tonnage of trains, but the profile of the track of the Reading road, are both remarkably uniform. The trains are all fully loaded to an established standard, and the road has no disturbing grades in the direction of the load. But for these circumstances, there would be some degree of difficulty in maintaining a uniform coal fire under all circumstances; and if this is not done a portion of the coal is likely to be wasted.

These remarks are made in order to show that the use of anthracite, however successful it may be on a few roads, would be influenced by different conditions on other roads; whereby, except with especial economy in its use, it might prove a more expensive fuel than wood. But it is not the intention of these remarks to discourage the general introduction of coal;—on the contrary, it is the purpose of this article to suggest means of increased economy in its use, whereby it may be profitably substituted for wood on a still larger number of roads than is now possible. We must first know what is the ultimate standard of economy in burning anthracite; and next, how near th present use of coal in locomotives approaches that standard.

We cannot judge of the economy of coal from the general performance of an engine, or the load taken and speed made in a given distance. The only

direct test of the economy with which coal is, or may be used, is in ascertaining the quantity of water evaporated by its combustion. When the heating value of coal has been expended, and when the steam which it has generated is ready to be taken from the boiler, all consideration of the heating value of coal ceases. The efficacy with which the steam may be afterwards administered in the cylinders has nothing to do with the fuel from which it was raised. But the weight of steam thus raised, or, as before stated, the quantity of water evaporated by a given weight of coal, is the direct practical test of the economy with which it is burned. For, the ultimate evaporative power of the coal being known, the actual heating value may be compared therewith, and the result will show with what relative economy it is being burned.

It is believed that the most accurate investigations yet made into the heating value of different coals, were those conducted by Professor Walter R. Johnson, in 1844, for the United States government.

That gentleman found the quantity of water, at 212°, evaporated into steam by one pound of "Forest's Improvement" anthracite coal (the kind used on the Reading road), to be 10.06 lbs. A reduction of 14 per cent. from this quantity, or to 8.6 lbs. of water, was considered safe for practical value. Allowing for the heating of the water, from its ordinary temperature to 212°, and the practical evaporative power of one pound of the above-named coal may be considered to be eight pounds of water, or one gallon. Practical experiments with steam-boilers for stationary engines, disclose an evaporation of from 7 1-2 to 9 1-2 lbs. of water from one pound of anthracite. And 10 lbs. of water have been evaporated by one pound of coal, in a tubular boiler. As a safe estimate for common boilers, where they are ordinarily well set and well protected, eight pounds of water may be considered as the evaporating duty of one pound of anthracite.

We are now to see how nearly this duty of coal is approached in some of the coal-burning engines now before the public. We have not been enabled to ascertain the precise result of the use of coal in any but the Winans' engines.

The result of 10 trips, made with the Winans' engine "New Hampshire," on the Reading road, showed an evaporation of 84,092 gallons, or 672,736 lbs. of water, with 110,096 pounds of coal. This did not include fuel used in firing up at the commencement of the trips. The water evaporated for each pound of coal was 6.11 lbs. and allowing for fuel used in firing, was probably 6 lbs.

The result of 10 trips of the Winans' engine "Minnesota," now on the Reading road, but, at the time of the experiments, on the Boston and Maine Railroad, showed an evaporation of 35,115 gallons, or 280,920 lbs. of water, by 47,859 lbs. of coal. This did not include fuel used in firing. The water evaporated for each pound of coal, was 5.87 lbs., and allowing for fuel used in firing, miget be called 5 3-4 lbs.

The report of George W. Whistler, Jr., Esq., on burning coal on the Reading road, states the quantities of coal and water, used by similar engines, on each round trip over that road, as 14,400 gallons, or 115,200 lbs of water, and 20,160 lbs. of coal, equal to 5.7 lbs. water for each pound of coal. It appears, therefore, that those anthracite coal burners which have been longest in use, and which are now most used, do not generally evaporate above 6 lbs. of water for each pound of coal consumed.

Compared with the ordinary evaporating duty of coal in other boilers, this result shows a loss of 25 per cent., and compared with the ultimate effect of coal, a loss of 40 per cent.

Coal engines cannot be considered as absolutely economical (although in some situations they may be relatively so as compared with wood), until a higher evaporating duty than 6 lbs. of water is obtained from each pound of coal. It is not the time to consider the general substitution of coal for wood

engines, until the former shall have been improved as far as possible, so as to yield the full practical value of the fuel consumed.

The construction of the boilers of the locomotives above referred to, is as follows:

The furnace is very long, say seven feet. It is quite shallow. The back of the furnace has no water space, but is closed by cast-iron doors. These doors have numerous openings for the admission of air, and for stirring and clearing the fire. The bottom of the furnace is left open, as in an ordinary wood burner. The grates are very heavy, and have spaces of from 1 1-2 to 1 3-4 inches between them. The grates being cast together in pairs, each pair may be rocked sideways by a hand lever, inserted in an eye in the outer end of each pair of bars.

The ash pan is made tight, and is covered on the bottom by water, so as to extinguish the burning coal which may fall into it.

There is nothing peculiar in the arrangement of the tubes. They are of iron, lap-welded, and are of 2 1-2 inches diameter. Iron lasts longer under a coal fire than copper, and the size of the tubes insures a free opening for the draught. The tubes are about 14 feet in length.

A variable exhaust supplies the draught for burning the coal. The exhaust nozzle being enlarged or contracted at pleasure, the draught under a given discharge of steam is correspondingly weakened or strengthened.

The chimney has no "cone," or any other obstruction to the discharge of steam and sparks, than a strong grating of iron bars.

It remains to be seen if, to any of the above details, a waste of coal can be attributed.

Coal is carried by the force of the draught through the tubes, and discharged from the chimney. In passing through the tunnels, enough can be seen of this discharge to create the conviction that a considerable quantity of coal is thereby lost.

Coal also drops through the wide spaces of the grate, especially when these are rocked to stir and clean the fire. All that drops is lost, and is raked out upon the track as so much refuse matter.

As from some cause, perhaps the want of a good active blast like that from a fan, the fire cannot be kept always open, some of the coal melts, and runs into "slag," without giving out its own share of heat. The formation of slag is, therefore, a loss of coal.

The constant admission of cold air through the back of the furnace,—this air passing over the top of the fire,—undoubtedly carries away a portion of unburnt or partially burnt gases; and thereby carries away unconsumed coal.

At any rate, the appearance of the inside of the smoke box after use, shows that gas of some kind is burned there; and much is evidently burned at the chimney top.

Again, there must be a considerable loss of heat by radiation from the outside of the furnace, which is very large, and wholly unprotected. If the barrel of a boiler requires lagging, a furnace certainly must, as from its great heat, radiation must go on faster from it.

Thus, five distinct sources of loss can be traced in the present plan of the Baltimore coal burners. How far these are influential in causing the entire deficiency in the evaporating duty of the coal, we cannot pretend to say. But our own judgment would lead us to believe that the above losses combined, are enough to absorb full 25 per cent. of the heating value of all the coal burned.

In our own opinion, a good share of these losses can be traced to the influence of the exhaust blast. And this blast also appears to involve some difficulties in managing the engine, and to cause other losses of steam power, after the steam has entered the cylinders.

The coal carried through the tubes is lost by the use of the exhaust blast. A fan operates by compressing air within the furnace, leaving the air to force itself out. The exhaust operates by rarification, and its effect is obtained by

the natural rush of air into the furnace. The two modes have different effects on the disposition of loose coal. The exhaust, at the best, produces but a partial vacuum, which, although sufficient to carry off moderate-sized lumps of coal, cannot keep a coal fire entirely free and open throughout, and for a great length of time. Its action is confined too much to the surface of the fire, "cutting up" the upper stratum of coal, and leaving some of the coal below to cake into "slag." The loss by the formation of slag may be charged to the exhaust blast.

The "Exhaust," instead of forcing in air to support combustion, withdraws the air already in, to create a current or draught of air. The result, with a solid coal fire is, that there is no support for combustion in the upper part of the furnace, except the air admitted through the back doors of the furnace. And this air passing above the fire, is carried too quickly into the tubes, to absorb the full portion of the heating element of the coal. The consequence is, that unburnt or partially burnt gases are carried away, with a loss of coal. At the same time, this cold air robs the boiler of a part of its just heat. Where this air should be heated in its union with the burning coal, it is not heated until the heating element of the coal has already taken the gaseous form, and ought therefore to be imparting heat. Any thing taken from the heat of the liberated gases is so much taken from the evaporating power of the boiler.

Three out of the five sources of loss already enumerated are therefore chargeable to the influence of the exhaust. They are the discharge of coal, the formation of "slag," and incomplete combustion in the upper part of the furnace. The first is evident to the eye, and the two others can be quite satisfactorily traced, without much pretension to chemical skill, to the influence of the exhaust also.

The exhaust blast is open to other objections. As the fire often needs urging without increasing the quantity of steam worked through the cylinders, the exhaust nozzle is contracted for that purpose. This throttles the exhaust of the steam and throws a back pressure on the piston; thereby diminishing the effective power of the engine.

But if the engine is standing, or only moving very slowly, the exhaust is either inoperative or inefficient.

Another of the first five sources of loss enumerated ought, perhaps, also to be charged to the exhaust blast. This is loss of coal through the wide spaces of the grates, aided by the occasional stirring of the grate-bars. This is done to keep the fire open, which the exhaust blast does not do. With a fan blast, applied at the bottom of the furnace, the grate spaces might be of ordinary width, and the bars placed permanently.

A form of boiler described by us, appears calculated to accomplish good results in burning coal. It is Phleger's boiler, having a close water-bottom under the furnace, water bridges in front of the tubes, and a fan blast. From what we have seen and heard of its working, we think it promises to realize very nearly the full effect of coal in the evaporation of water. The durability of this boiler is a point on which we cannot speak, and must be settled by experience.—*R. R. Advocate.*

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### MACHINE FOR WASHING COAL.

The great advantage of purifying coals for most manufacturing purposes, and of utilizing the inferior portions of coal-seams, is now strongly felt, if we may judge by the number of machines which have been proposed to effect the removal of the impurities. This machine is simple in the extreme. It consists of a large circular cistern cooped in the ordinary way, in which a wooden framework or agitator is made to revolve by means of an upright shaft driven by suitable gearing. The bottom is dished, and in its centre is a hole, to which a sort of cast-iron conical pocket is fitted, the lower end of which is

closed by a valve opening downwards into a canal with a bottom of wire gauze. Immediately above the bottom three pipes enter at equal distances from one another for the purpose of supplying a constant flow of water. A little above the level of these, at one side, is a rectangular opening provided with a valve, which opens upon another canal with a wire gauze bottom. The cistern is kept about three quarters full of water; and the small coal carried up by a chain lift or other mechanism, falls by means of a hopper into the water. The motion of the agitator causes the fragments to describe curves of more or less length, and this allows time for them to arrange themselves according to their specific gravity. The fragments of schist and pyritic coal, being much heavier than pure coal, fall at once on the inclined bottom, and then through a grating pass into the pocket above mentioned, which is emptied from time to time by means of the valve. The fragments of pure coal escape with the water through the rectangular opening, and fall upon the grating, which has an oscillating motion, which serves to project the coal into a wagon or vehicle, whilst the water escapes through the grating.

Two men would be sufficient to work a cistern of about 40 ins. high and 40 inches in diameter, and capable of washing about 20 metrical tons in the day with a force of one horse. A cistern of about 9 feet 10 ins. in diameter and depth would wash 200 tons in the day, and would require a force of 10 horses to work it. The smaller machine would cost about £80, and the larger about £400.—*Bulletin de la Société Industrielle de Mulhouse*, No. 123, p. 292.

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# IRON AND ZINC.

### IRON MINES OF MORRIS COUNTY, NEW JERSEY.

*Editor Mining Magazine*,

If the people of Jersey wish to arrive at the real benefits that they may derive from those vast deposits of ores, they must cease to send it to Pennsylvania, to be there converted into pig, and manufacture it on their own soil. As it is undoubtedly from making iron, not from mining ores, that the owners of those mines can receive any profit, or even get a value for their mineral property, after paying the expenses incurred by the mining of the ores and carting them to the canal for transportation, from the present price of iron ore, they will have little left for their property. Some of the mines produce a very superior quality of ore, but, perhaps the average yield is about from 60 to 65 per cent. of pure iron.

Since the depression in the mining market, and, in consequence, the unfavorable impression it had on almost all kinds of business, mining operations have not been carried on to the extent they were two or three years since. I should judge that the number of tons of ore mined in Morris County last year (1855) was about 90,000 tons; of this amount about 38,000 tons were mined by the different iron manufacturers themselves; about 42,000 tons were mined by the different owners of mines not connected with any manufactory, and sold to the different manufacturing companies, of which nearly all are in

Pennsylvania; and about 10,000 tons lay on the docks of the Morris Canal not sold. The number of mines in operation, and which produced this amount, was eighteen; consequently, we find that those eighteen small openings produced 90,000 tons of ore, which was sold at about an average price of $3.50 per ton, which is $315,000. Adding thereto the cost of transportation on the Morris Canal, which is paid for by the different purchasers of the ores, and consequently does not affect the above estimate, the value of this amount of ore to the State was perhaps about $350,000; but this is very small to what even the present openings or mines that are in operation are capable of producing. I may safely assert that the mines now opened, can easily produce, without working them to any inconvenient extent, 160,000 tons of iron ores per annum, that would yield not less than 60 per cent. of pure iron; if sold at the present low price to the iron manufacturers of Pennsylvania it would amount to $560,000. There would be no difficulty in mining from Morris County alone, and this could be done by a small outlay, 200,000 tons of iron ore per annum that would yield 60 per cent. of iron. Besides the eighteen mines now in operation, there are a number now idle, that have been worked heretofore.

A Miner.

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MANUFACTURE OF STEEL BY ELECTRICITY.

In contradistinction to the ordinary method of manufacturing steel, it may now be stated that a process has been discovered of converting iron into steel by a current of electricity passed through the iron when placed in a furnace, and embedded in charcoal, whereby an immense saving of both time and fuel is the more immediate result. The furnaces used in the instance now referred to, were fitted with two distinctly separate and independent compartments or boxes. One was filled with the common Swedish or bar iron, and the other with scrap and bar iron, indiscriminately mixed in about equal proportions: the former was intended to be not so highly carbonized as the latter. The battery was placed, and generally so arranged, that the electric current should pass either through both, or through only one, of these compartments respectively, as required. After the furnace had been brought to the proper temperature, which occupied the usual time, the battery was set in action: the electric current was passed through both boxes simultaneously for 24 hours, when a trial bar was drawn from the box which contained the bar iron required in only the lesser degree to be carbonized. From the various tests to which this bar was subjected, it was found to be sufficiently carbonized, or converted into steel, although it was deemed expedient that the action of the current of electricity should be continued during another six hours, for "soaking," making the entire period of 30 hours continuously. The current was then applied to the remaining box or compartment alone for 72 hours in addition, at the expiration of which time the action of the battery was suspended, and the furnace was allowed gradually to cool. Highly carbonized steel was found to have resulted, which was thus produced through continuous electrical agency. That quantity of iron which for the longest period had been subjected to the electric current, was found in the highest degree to possess the respective qualities of hardness and carbonization. On the second experiment, which was intended to reduce the operation of the manufacture of steel within the nearest possible limit of time, the furnace, accordingly, was charged with foreign iron required to be highly carbonized, of a quality fitted (say) for the manufacture of files. On subjecting the furnace to the customary heat (the usual time being 64 hours firing), the electric current was applied, and maintained in continuous action during the space of 48 hours, at the end of which time the battery was taken off, and the firing carried on for six hours longer.

A trial bar was then drawn from the furnace, after the battery had been in action during 45 hours; and, from the appearance which the metal then presented, it was judged to have been sufficiently carbonized, excepting that six hours' extra firing was allowed for what is technically termed "soaking," or, rather, for the diffusion of carbon throughout the integral substance of the iron, which in the process of converting, is received in the greater or lesser degree—in some places more than in others. After the necessary time had been allowed for cooling, the steel was taken out of the furnace, which discovered that portions of the metal were wanting in the required uniformity, whereas others possessed an undue degree or amount of hardness, which showed that either the battery was not applied at a sufficiently early stage, or that a few hours were wanting in the "soaking" process. It was, however, concluded that, had this operation been continued for six, or even for twelve hours longer, the result would have secured more perfect uniformity throughout the entire bulk of metal, and a saving, by this process of manufacture through the continuous electric current, amounting to at least 20 per cent. in labor, time and fuel.

The results of these experiments have, however, demonstrated that, in the manufacture of iron, the agency of electricity can be applied with immense advantage, since there is every reason to conclude, that iron can now be made through this process, even from ores, equal in purity to the finest iron at present imported. On the other hand, in the operation of the conversion of iron into steel, it will give a greater power of governance to the operators, inasmuch as the application of the battery for a certain time will insure a certain amount of carbon being taken up, absorbed, or concentrated and amalgamated with the iron; and thus, by increasing or diminishing the action of the battery, different qualities of steel will be produced, with a certainty, regularity, and efficiency which, hitherto, under the ordinary process of manufacture, has been the object wanting—the great desideratum sought after, as well as the end desired to be attained. The experiments were conducted at Sheffield, under the superintendence of Mr. Hunt, and in conjunction and conference with Messrs. Atkinson, of that place. If, on a more extended scale, the electric process should be found practicable, we may yet have cast-iron mortars, guns, and ordnance, at once carbonized into steel, and lowered in rigidity, toughness, and ductility, as well as in tensile properties, to any degree or amount of temper.—*London Mining Journal.*

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### UNION OF SULPHUR WITH IRON.

Mr. Janoyer, a smelter, in the Department of Loire, in France, describes in the *Annales des Mines* some investigations relative to the union of sulphur with iron, and the neutralizing influence of phosphorus upon the action of the former. We can only state the results of his experiments and analysis:—1. Traces of sulphur are sufficient to make forge iron redshort. 2. The union of sulphur with iron occurs principally in the smelting process, through the influence of pyrites on the combustible mineral, wherefore care must be taken to guard against this union. 3. Phosphurets mixed with the ore will neutralize to a certain extent the sulphur. The phosphorus replaces the carbon and facilitates the formation of carburets. 4. If pig iron or bar iron be smelted with iron pyrites, or exposed to a red heat, it does not lose its sulphur. 5. But iron slightly impregnated with phosphorus, works easier, and derives from it a certain degree of hardness. 6. It requires a close knowledge of the component parts of the melting mass to prevent the admixture of an excess of phosphorus, which would render the iron coldshort.

### ALLOY FOR COMPOSITION FILES.

The metal of the so-called composition files, which are employed in the application of polishing rouge to small metallic objects, is an alloy of silvery whiteness. These files are used principally by watchmakers for polishing steel pins, and for the production of the deep black polish of some parts of watches. The analysis of a file of this description, of 6 in. in length and five lines in breadth, made of a yellowish-white metal, which was very brittle under the hammer, and had a jagged fracture, gave:—

| | |
|---|---|
| Copper | 64.4, or 8 parts. |
| Tin | 17.6, or 2 parts. |
| Zinc | 8.0, or 1 part. |
| Lead | 8.6, or 1 part. |

The author then melted the four metals together under a coat of borax in the above simple proportions. The alloy filled the clay mould well. It is so brittle that it can scarcely be worked with the file; the rods of metal are, therefore, best ground on a mechanical grindstone, to give them the surfaces required for each particular case. The alloy above mentioned gave files of as good quality as that employed for analysis. The composition is sold at 5 florins per pound. From the price at which the metals required for the alloy are to be bought in small quantities, the pound poured into moulds and ground may be calculated at 1 florin 12 kr. The base, by means of which the polishing agents are applied, is of the greatest importance in polishing, and the alloy here described is particularly good. It has, probably, been obtained empirically by trials. The author has found that inconsiderable changes in the proportions of the metals exert a great influence upon the usefulness of the alloy. —Prof. A. VOGEL: *Neues Jahrbuch für Pharm.*, vol. iv., p. 138.

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### ON ALLOYS OF IRON AND ALUMINIUM.

By Prof. CALVERT.

Messrs. Calvert and Johnson, of Manchester, have succeeded in preparing the following alloys of iron and potassium:—1st alloy: 4 equivalents of iron, 1 ditto of potassium. 2d alloy: 6 equivalents of iron, 1 ditto of potassium. These alloys were prepared with the view of solving one of the great chemical and commercial questions of the day—namely, that of rendering iron less oxidable when exposed to a damp atmosphere; as these gentlemen believe that no kind of coating can be discoverd which will resist the constant friction of water, as is the case with iron steamers. They have also succeeded in producing two new alloys, composed of iron, combined with that most valuable and extraordinary metal, aluminium, lately obtained by M. St. Claire Deville. These two alloys are composed as follows:—1st, 1 equivalent of aluminium; 5 ditto of iron. 2d, 2 equivalents of aluminium; 3 ditto of iron. The last alloy presents the useful property of not oxidizing when exposed to a damp atmosphere, although it contains 75 per cent. of iron.

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### FIRTH'S METAL FOR JOURNALS.

We have received the following communications from a gentleman engaged in obtaining information regarding this metal. It is his report to certain parties who are interested to know its merits.

DEAR SIR:—Agreeably to your request, I have spent a month in investigating the qualities of Thomas Firth's White Metal Composition, which is manufactured No. 29 Congress street, in this city, and used instead of brass and babbit metal for journal boxes. I have travelled over two thousand miles, and examined a thousand cars. The master machinists have kindly assisted me in my examinations.

Its chief recommendation is its not cutting the journal. This would be a

saving were it *ten* times the price of any other material, because, let a journal become cut, the car has to be taken to the shop, the wheels taken off, and a *new* axle put *in;* there is a week's detention of the car, perhaps in a busy season, when it might have earned 100 times the amount, and $20 for a new axle. I have known a car to require a new set of axles *twice* during the year, and that upon a well-ballasted road, with the brass box and the babbit metal. I have yet to find a *single* journal cut by this metal; it is now in use upon 3,000 miles of railroad. This metal can be made by companies who make their own boxes, for twelve cents a pound, when the brass box costs as high as 40 cents.

I find that it wears as long. I have one before me now, which was recently taken from the Cincinnati, Hamilton & Dayton Road, which has been running eleven months, and that is much longer than the average duration of the brass box (it being from 3 to 4 months). Now, sir, let us see the difference in favor of this box as it regards economy, which every road ought to look to in these days of improvement. Take, for instance, 100 cars, upon which the *experiment* has been tried.

| | |
|---|---|
| 100 cars = 800 boxes, say of brass and babbit metal, weight 4 lbs. each at 40 cents, | $2 40 |
| 100 cars = 800 boxes of Firth metal, weight for same size of box, 5lbs. at say 15 cents, | 75 |
| Difference in one box, | $1 65 |

800 = $1,800 replenished 3 times a year = $3,900.

Take a road of the length of the Illinois Central, or New York & Erie, which require 3,000 cars, saving per year would be $117,000 a year. Now add to this the saving in journal and use of car, and you have a nice little item of saving. I here submit the question. All these facts are capable of proof; it remains for you to determine whether you are studying the interest of your road in not immediately adopting this metal.—*Railroad Record.*

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PIG IRON, CHEMICAL COMPOSITION AND COMMERCIAL VALUE.

The pig iron of Lowmoor, made in coke-fed, cold-air blast furnaces of the dimensions above described, is the best I have seen. That of Staffordshire is of inferior appearance—close grained and full of blisters. At Lowmoor, all the pig iron is rejected which shows a confused and homogeneous crystallization; none is accepted unless the grain is full of crystalline facettes and bright particles uniformly dispersed through it. The same species of crystallization is observable in good pig iron smelted with wood, and the spangles are larger and more numerous.

The following table presents a comparison of the Lowmoor iron, both rough and refined, with several American irons. The analysis of the latter I take as I find them by American chemists, though some of the works mentioned are no longer in operation.

| Chemical composition. | Montour's Ridge. | American Furnaces. McNichel's Furnace. | Farrandsville. | Danville. | English Furnaces. Rough Iron No. 1. | Refined Iron. |
|---|---|---|---|---|---|---|
| Carbon { com'd | 3.500 | 3.900 | 3.120 | 2.980 | 3.500 | none |
| Carbon { graphite | | | | | 0.600 | 1.500 |
| Silicium | 0.100 | 5.440 | 2.400 | 2.030 | 0.600 | 0.100 |
| Manganese | 0.224 | 0.120 | 0.070 | 0.050 | 1.800 | traces |
| Phosphorus | none | traces | none | none | 0.800 | 0.200 |
| Aluminium | traces | 0.650 | 0.500 | traces | none | none |
| Chrome | none | none | none | none | none | none |
| Sulphur | none | traces | traces | none | 0.020 | none |
| Metallic Iron | 96.100 | 89.530 | 93.910 | 94.940 | 92.680 | 98.200 |
| Total | 100.000 | 100.000 | 100.000 | 100.000 | 100.000 | 100.000 |

The refined metal, above mentioned, is the kind which undergoes a purification in a special furnace.

*Carbon.*—The two modes in which this element exists in the English iron, is noted quantitatively in the above table. The pig iron of Lowmoor is more graphitic than the American specimens compared with it. It will be noticed that the refining process burns a portion of its graphite and brings the excess back to the state of combined carbon. The mode and quantity of carbon in pig iron affects little except the rapidity and economy of the refining process; the purified metal must be more rapidly convertible into iron. The small proportion of carbon in the purified metal is not enough to make it entirely fusible in the puddling furnaces. In them it will not go beyond the spongy state. This remarkable phenomenon has great influence on the method of puddling.

*Silicium.*—The American pig iron is more heavily charged with this than the English, but a great deal of it is lost in the refining—a loss which renders ulterior working much easier.

*Manganese.*—The difference is very great, as marked in the table.

The Lowmoor pig iron contains an unusual quantity of this metal, and the refined metal hardly any. It is important to note this disappearance of manganese coinciding with that of the noxious materials. This fact, taken with another to be mentioned hereafter, has forced me to the conclusion that the purification (whether in refining, fining or puddling furnaces) does not depend entirely on the oxygen of the air, but also on the decomposition of the metallic peroxides, a decomposition resulting in slags and disengagement of oxygen. This gas, being set free in the very heart of the mass in fusion, acts in a manner which affects only the surface of the bath.

Just before liquefaction the oxygen of the air attacks the metal to produce peroxides. The manganese is the first to be oxidized, and at the same time, absorbs most oxygen. The peroxide thus formed is peculiarly decomposable by acids, so that on liquefaction, the silicic acid separates into protoxides, forming slags, and sets a certain amount of oxygen free. It is certain that the manganesiferous pig yields excellent iron. The Lowmoor pig, containing noxious substances, is a striking example. Manganese in pig iron, may be considered as a purifying agent, enclosed among the noxious substances it is intended to destroy. The crude pig irons of Lowmoor are apparently more impure than those of the American works, because they contain sulphur in large proportion; but the remarkable proportion of manganese they contain contributes powerfully to purify them when they are subject to the refining process; the puddling ovens receive an exceedingly pure product. This makes evident the propriety of the system of puddling adapted to the material to be used.—*Schmitz.*

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### IRON IN TENNESSEE.

From private letters from gentlemen well posted in the iron business in Tennessee to dealers in this city, we are permitted to make the following extracts:

"From the information we have, and the prospects of the iron interests generally, in the West, we are of opinion iron will advance. Tennessee furnace men are holding firmly, some asking as much as $30 on the bank, 6 months' time, for a No. 1 article of foundry metal. Many furnaces will not run this year, and several others will not do more than half year's work, on account of scarcity and high price of hands.

"The iron business in Tennessee is carried on exclusively with negroes, which have been hiring this year at $225 a piece. The farmers have been doing too well to hire out their hands at less rates.

"The unprecedented cold weather has also set back furnace work at least six weeks—it was almost impossible to make coal or raise ore during the winter. From the above and other causes, the prospects are that iron will rule $5 or $6 higher per ton this year than it did last."—*St. Louis Price Current.*

MISSOURI IRON.—METAL AND BLOOMS PRODUCED FROM ORE IN 1855.

The St. Louis and Iron Mountain Railroad and the South-west Missouri Railroad, which penetrate the iron regions of Missouri, are not yet finished; and, although the Iron Mountain Railroad is bound to be completed by the 1st of December, 1856, according to contract, and although 2,000 laborers are at work along the lines, yet from their present progress and prospects, neither of these roads will reach their respective iron regions until some time in the year 1857.

We mention these facts as apologies, for the small amount of metal and blooms produced from the iron ore in Missouri, in 1855; for the cost of present transportation to market forbids the propriety of erecting any more furnaces and forges than are already built, and also prevents those already erected from producing more than half their capacity.

The works in operation for converting iron from ore in Missouri, in 1855, were: three furnaces at the Iron Mountain, and one forge with 10 fires, called Vallé Forge, near Farmington, in St. Francis County; two furnaces and one forge with eight fires, at Pilot Knob, in Madison County; one furnace in Franklin County; and one furnace and one forge in Crawford County.

We have received accurate figures from the iron works in St. Francis, Madison and Franklin Counties; and from the best information obtained of the Crawford County works, we conclude that the total iron products of these four counties during 1855, were:

| | |
|---|---|
| Pig metal | 12,500 tons |
| Wrought blooms | 1,700 tons |
| Amount of iron from ore | 14,200 tons |

The value of Missouri pig metal has ranged, during the year, from $30 to $35 a ton. We have estimated the average at $32 a ton; and the average value of Missouri blooms at Ste. Genevieve is stated at $60 a ton.

At these average rates the value of iron made from the ore in Missouri, during 1855, was:

| | | |
|---|---|---|
| Pig metal | 12,500 tons, | Value $400,000 |
| Blooms | 1,700 tons, | Value $102,000 |
| Total iron | 14,200 tons, | Value $502,000 |

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## JOURNAL OF GOLD MINING OPERATIONS.

HYDRAULICS IN AMADOR COUNTY.

MAHALA FLAT.—This mining locality, situated at the south end of our town, is one of the best places we have seen lately. Wednesday last we visited the flat, and were greatly surprised to see the amount of work that is being done there, and to hear that so much gold was taken out. We counted no less than fifteen large "hydraulics," and the most of them in operation—there being a pretty good supply of water now furnished by Sutter Creek. Most of these claims are paying handsomely, with plenty of ground to work.

This method of washing away the earth has been introduced in one or two instances in North Carolina, and we are told that the results have been favorable. For a description of it see vol. 1, page 161, Mining Magazine.

of business, where the efficiency of the Mint, and the security of the treasure therein, will be greatly advanced and promoted. During the suspension of coinage, deposits were received and paid as heretofore; so that no inconvenience to depositors has resulted therefrom. But the accumulation of bullion and the necessity of supplying coin, especially to the Treasury of the United States, have made it necessary to resume the coinage operations, notwithstanding the work upon the repairs is in an unfinished state. The preparation of standard ingots for coinage was commenced on the 4th of the present month, and the delivery of coins to the Treasurer was resumed on the 19th inst. The Mint is now in active and efficient operation, although considerable inconvenience is experienced in consequence of the repairs not being fully completed. The suspension of coinage for a period of six months will sufficiently account for the diminished operations of the principal Mint during the past year.

The deposits received at the Branch Mint at New Orleans amounted to $2,852,510 69, of which the sum of $431,156 83 was in gold, and $2,420,953 86 in silver. The coinage was $450,500 in gold, and 1,918,000 in silver. Total coinage, $2,368,500; the number of pieces struck was 5,556,100.

The Branch Mint at San Francisco received of gold deposits the sum of $20,876,310 08; of silver the sum of 259,787 47. The coinage operations were as follows: Gold coin, $17.598,300; fine gold bars, $88,782,50, unparted or unrefined gold bars, $3,270,594 93; silver coinage, $164,075. Total coinage operations, $21,121,752 43—comprised in 1,471, 272 pieces.

The deposits received at the Branch Mint at Dahlonega were, in gold, $116, 662 07; the coinage (gold), $116,778 50; the number of pieces struck was 25,366.

At the Branch Mint at Charlotte the sum of $216,988 86 was deposited for coinage. The coinage comprised in 55,268 pieces, amounted to $217,935 50. The operations of this branch, as well as that established at Dahlonega, are confined to gold.

The Assay Office at New York received during the year the sum of $26,687,701 24 in gold bullion, and the further sum of $350,150 08 in silver; of this amount, the sums of $195,241 44 was parted from gold, and $2,061 87 was derived from the Lake Superior mines. The number of fine gold bars stamped at this office was 6,182, of the aggregate value of $20,441,813 63. For the bullion deposited during the year, payment has been made in fine gold bars to the amount of $17,246,247 74, and in coins to the amount of $9,791,-603 58.

The entire amounts received at the Mint and its branches, including the Assay Office, during the year, were as follows: Gold, $58,862,922 92; Silver $5,711,448 19. Total, $64,574,371 08.

The coinage operations for the same period were as follows: Gold coins, $28,977,968; fine gold bars, $20,546,894 27; unparted bars, $3,270,594 93; Silver coins $3,501,245; Copper coins, $16,030 79. Total coinage, $56,312,732 99; comprised in 16,997,807 pieces.

It is proper to remark that the aggregate of the deposits above presented, embraces a considerable amount of redeposits, as for example, unparted or unrefined bars, made at San Francisco, are sometimes redeposited at the other minting establishments, and a portion of the fine bars formed at the Assay Office are transferred to the Mint for coinage. Deducting these redeposits, the actual amount of the precious metals brought into the Mint and its branches during the year was $55,151,902 37.

The amount of gold of domestic productions deposited in 1855 was, $49,351,789 11, viz: from the Pacific side of the Union, including a deposit of $900 from New Mexico, $48,989,439 54; and from the Atlantic States, $362,349 57.

Since the passage of the act of March 8, 1853, authorizing a reduction in the weight of the silver coinage, there have been issued the following amounts, *viz: In 1853,* $8,654,161; in 1854, $8,619,270; in 1855, $3,501,245—making

a total of $20,774,676. As few, if any, of these coins have been exported, and but a small amount used in the arts, it will be seen that a large addition has been made to the silver coinage in circulation. The issuing of a few millions more of silver coin may be all that may be required in view of the exclusion of the circulation of silver and the small denominations of the gold coinage, in many of the States of the Union, by the use of bank notes of a low denomination. We shall never, it is believed, fully realize the benefits of a sound specie circulation, until all bank notes, at least below the denomination of twenty dollars—shall be excluded from circulation. And it seems worthy of the consideration of Congress—as suggested in the Mint Report of 1853—whether some provision is not practicable, either by taxation or other efficient means, to remedy the evil in question.

It may be interesting to present, in one view, the entire coinage operations of all the Mints and the Assay Office, since their organization. They are as follows:

| | |
|---|---|
| Mint of the United States, Philadelphia, (1793)..... | $377,338,808 87 |
| Branch Mint at New Orleans, (1838)..... | 57,886,665 00 |
| Branch Mint at Dahlonega, (1838)..... | 5,690,266 00 |
| Branch Mint at Charlotte, (1838)..... | 4,222,626 50 |
| Branch Mint at San Francisco, (1854)..... | 30,853,326 64 |
| Assay Office at New York, (1854)..... ..... | 23,329,872 81 |
| Total..... | .$498,8 ,565 82 |

The chief part of this large amount has been received since December, 1848, and is the production of the mines of California, viz: $313,234,502 77. In a former report some reasons were suggested tending to show that the large amount of gold from California, and that produced from Australia, need excite no apprehensions in regard to any material disturbance in the value of the precious metals; yet it cannot but be apparent that this increase renders it highly important that States and nations should extend the uses of gold, and drive out of existence that which circulates in place of it.

There is one point connected with this subject and the general management of the national coinage, which although left by law to the discretion of the Director of the Mint, and cannot be made the subject of particular legislation, yet it is of so much importance to the community generally, that this occasion seems appropriate to give it a fair and general understanding. The 30th section of the General Mint Law—Act of Jan. 18, 1837—provides that "in the denominations of coin delivered, the Treasurer shall comply with the wishes of the depositor, unless when impracticable or inconvenient to do so; in which case the denomination of coin shall be designated by the Director." In view of the fact, that the depositors are always paid before the bullion is operated upon from a stock of coin previously made ready, it is evident that in the preparation of such a supply of coin, the Director is to use his discretion in regard to the denominations before conferring with depositors; and they may or may not be exactly suited in the payment. Undoubtedly, in the issue of coins, every proper attention should be given to the probable demand, and especially in the silver coinage, which it is to be presumed is wanted for immediate use and not for storage in vaults. Heretofore the general practice has been to pay depositors in the coin they have desired, and it is not intended by these observations to give notice that this usage will be entirely abandoned. But the chief design of a National Mint is to subserve the interests of the people at large, preferably to a few large owners of bullion or coin. The interests of the public and of depositors are not always concurrent in the matter under discussion. Depositors of large amounts call for their coin in a form which gives the least trouble to count; and banking institutions, in addition to that, may prefer it in a form not likely to be drawn out. Many who present their checks at those institutions would doubtless ask for specie, but are deterred from doing so by the expectation of receiving double eagles instead of half or quarter eagles. In a word, the plain effect of issuing gold coin of

a large size is to keep down the circulation of specie and increase the use of paper money. This remark of course does not apply to such localities where paper money is prohibited, as, for example, in the State of California, because in such case the different currencies cannot come in conflict. Before the act of Congress authorizing the issuing of gold in stamped bars, there was, it is true, a necessity for the issue of large coins, as well to meet the demand of shipment to Europe, as in some measure to relieve the pressure upon the Mint. There was no kind of propriety in going through the manipulations and bearing the expenses of making small gold coin, to be directly melted down in foreign mints or refineries. But since the important change in our mint laws, before referred to, a distinction has been made to meet the demands of trade by which gold intended for exportation is cast into fine bars, while that which is needed for home consumption is converted into coin. If we look at the example of the wealthiest and most civilized nations of the globe, we shall find that their largest gold coin, to speak in a general way, does not exceed our half-eagle in value. Such is the case in Great Britain, France, Russia, the Netherlands and other countries. There are pieces of 10 thalers, about $8 of our money, coined in Germany, but apparently for international use. The same may be said of the American doubloons, of which the amount coined is small. It would no longer be an embarrassment to the principal Mint, nor to the branches, excepting perhaps the branch at San Francisco—and to that institution these views are not intended particularly to apply—to coin all the gold that is likely to be offered in pieces of $5 and less. It is true that nearly as much labor is expended in the manufacture of a gold dollar or a quarter eagle as of an eagle or double eagle, and in thus offering to make the smaller denominations a large increase of work is assumed; but this consideration is met by another, that the division of labor and the present efficiency of the Mint establishments, especially when the repairs at the Mint are fully completed, will enable us to meet such increase without additional expenditure.

The manufacture of fine bars at the Assay-Office in New York, and the coinage of the branch Mint at San Francisco, have so divided the work upon gold bullion as to remove all apprehension of difficulty or delay. In the coinage of the half-eagle, particularly, we shall be materially aided by a very remarkable machine lately invented for the final adjustment of the weights of the individual planchets. This instrument was manufactured at Paris, and has been introduced into the Mint there, and one of similar powers is also employed in the Mint of England. The one imported for the United States Mint is adapted to the half-eagle only. It is justly regarded as a triumph of mechanism. It is not by any means assumed that the coinage of the eagle and the double-eagle should be discontinued; on the contrary, they will be indispensable at San Francisco; they may in some emergencies be required at Philadelphia and New Orleans; but as a general rule, adapted to the principal Mint and to the branches in the Atlantic States, it is believed that the time has come to return to the smaller denominations of gold coin; issuing almost the whole in pieces not larger than the half-eagle, and this upon the ground already adverted to—particularly applicable to a country so greatly favored with the original production of the precious metal—that the people at large are entitled to a greater portion of real imperishable money, and that a cardinal point at which this reform is to be begun or aided, is the place where the gold is put into shape and size for circulation.

The propriety of the organization of a medal office at the Mint is respectfully recommended to your consideration. The reasons for this measure, heretofore presented, need not be repeated here. The frequent calls upon us to strike medals, and to furnish copies of the public medals, from the dies which are deposited at the Mint, indicate that the establishment of such an office would be of great public benefit. As the statement of the medal dies annexed to my last report did not embrace all that are at the Mint, and was in one or two other particulars not precisely accurate, I have caused a more correct list to be prepared, which is herewith presented.

I also attach to this report several tabular statements, exhibiting the full details of the operations of the Mint and its branches, including the Assay Office, for the past year; also several statistical tables relating to the deposits and coinage of previous years, and showing the States and Territories from whence the precious metals have been received.

I have the honor to be, with great respect, your faithful servant,

(Signed,) JAMES ROSS SNOWDEN, Director of the Mint.

To the President of the United States.

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GRASS VALLEY QUARTZ MINING COMPANY.

A few days since we paid a visit to the mine of this Company, situated on Osborne Hill, about two miles in a south-easterly direction from town. The vein was first opened in the spring of '52, but little, however, was done towards developing either its extent or value, until the fall of '53, when the principal portion of the mine passed into the hands of this Company. Messrs. Crosset & Scott, the managing agents of the Company, then commenced working it on a more extensive scale. From the time they first commenced operations up to last spring, about 2000 tons of ore had been taken out and hauled to their mill, near Boston Ravine, about two miles distant, and there crushed. The results from this rock were highly satisfactory, and enough had been crushed to prove not only the continuousness, but also the yield of the vein, and to establish its reputation as one of the best-paying mines in the State. Satisfied upon this point, the company now resolved to make preparations for a still more extensive and thorough working of the mine. To this end they placed a steam engine with a pump and hoisting apparatus at the mouth of their main shaft, and enclosed the same in a substantial frame building of suitable dimensions and construction. The pump—a force and lift pump, of six inch bore—was placed in the main shaft, which raises the water to the surface, a distance of 107 feet, at which depth said shaft intersects the vein. Since this pump has been fixed they have gone down on the dip of the vein sixty-five feet lower, and are now putting in another pump, with a six-inch working barrel, which will work on the incline of the vein, and raise the water from the present lowest point of working to the well of the main pump, through which it will be raised to the surface.

All the hoisting is done by steam power. The shaft is divided into two compartments, in one of which are placed the pump and ladders for the descent of the workmen, and through the other the tub for raising the ore and waste dirt is worked by means of the machinery above.

Having divested ourselves of our broadcloth and beaver, and substituted in its stead a miner s "rig," we were prepared for a descent. Passing from the platform over the shaft, through a small square aperture, we descended by a stationary and almost perpendicular ladder about twenty feet, where we reached another platform, through which we passed by a similar aperture, to another ladder, which in turn landed us on a still lower platform, and so on until we reached the bottom of the main shaft. This is the usual method of descending shafts. Having reached the bottom we found ourselves in a large open excavation, directly upon the line of the vein. Upon our right a level stretched away northwardly 250 feet from the shaft, and another upon our left 200 feet south. From this point descending down the incline of the vein, about thirty-five feet, we came to another level, running 150 feet north and 100 feet south. Passing downwards, still following the dip of the vein, about thirty feet lower, we arrived at the lowest point yet reached in the vein.

From this point, looking northward, a breast of vein rock, gradually receding, and opened up to the upper level, presents an approachable working surface of 150 feet. The process of opening up the vein on the south side, in a similar manner, is also in a good state of forwardness.

A large amount of deadwork has been done upon the vein, during the

last year, which has been accomplished at great expense, owing to the excessive hardness of the enclosing rock.

The greenstone was struck in this vein at the depth of one hundred feet, at and below which point the vein has proved both heavier and richer than the average above, proving that the vein is continuous, and may be followed to any practicable depth below the surface. The ground which has been drifted out, as well as all the open galleries, are carefully and substantially secured both by timbering and walling. This vein has long been considered one of the most valuable about Grass Valley, and we are pleased that it is now in a fair way to be worked in an extensive and thorough manner. The Company is now running a mill of ten stamps, of 800 pounds each, to which has just been added an arastra. From thirty to forty men are kept constantly employed at the mine and mill.

The location of this vein is highly advantageous for extensive working. The topography of the county being such as to admit of drainage of 400 feet on the dip of the vein by running an adit of 1500 feet, which would strike the vein upon its back and at nearly right angles with its direction, which is N. E. and S. W. The company holds a large extent of ground, fully sufficient for the most extensive operations; and have been thus far one of the most successful companies in Grass Valley.—*Grass Valley Mining Journal.*

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QUARTZ MILLS IN GRASS VALLEY.

Quartz mills in the neighborhood of Grass Valley, with their weekly working capacity when at work night and day.

| | | |
|---|---|---|
| Scott & Crossett's mill | 100 | tons. |
| Gold Hill | 300 | " |
| Empire | 150 | " |
| French | 70 | " |
| Helvetia & Lafitte | 80 | " |
| Laramie's | 40 | " |
| Orleans | 50 | " |
| Lee's | 40 | " |
| Whigham's | 80 | " |
| Mount George | 80 | " |
| Total | 990 | " |

Say nine hundred and ninety tons, which at an average yield of twenty-five dollars per ton, we have a weekly produce of twenty-four thousand seven hundred and fifty dollars. This calculation is based upon all the mills being constantly employed, which they are not, as few, if any, of the leads are sufficiently opened to admit of working without interruption from water.

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# JOURNAL OF COPPER MINING OPERATIONS.

LAKE SUPERIOR REGION.

The information from the mines in the Ontonagon District for the few weeks past has been of a very favorable character, and notwithstanding the great draw-back occasioned by the non-arrival of supplies last fall, we are happy to state that the yield for the present season will considerably exceed that of any preceding year. S. W. Hill, Esq., of Eagle Harbor, a gentleman *well acquainted* with mining matters, who has recently made a thorough ex-

amination of every copper-producing mine on the Mineral Range, estimates the product of the year, in the Ontonagon District, from November 1st 1855 to November 1st 1856, at 2,800 tons; which estimate, if correct, and we are quite confident it is not overrated, will show an increase for the current year of over 600 tons. How much this product would have been enhanced had the freight for this point reached its destination, it is impossible to calculate; but we are quite confident but for this misfortune several hundred tons would have been added to the year's shipment. As we have before stated, several of our most promising mines have been obliged to greatly reduce their force from this cause, and as a natural consequence will be unable to meet the expectations of the agents and stockholders. We annex below the receipts of copper since the close of navigation, "20th Nov.," which, however, is only a small portion of the amount produced, as many of the mines from various causes keep their product at home until after the opening of navigation. The Minnesota and Rockland may vary a little from the quotations, as we have been unable to obtain the exact figures, but the discrepancy will be but small.

| | tons. | lbs. |
|---|---|---|
| Minnesota and Rockland | 350 | |
| Douglass Houghton | 4 | 1758 |
| Toltec | 10 | 102 |
| Aztec | 25 | 852 |
| Nebraska | 8 | 1287 |
| Ridge | 14 | 1205 |
| Adventure | 26 | 1698 |
| National | 17 | 405 |
| Forest | 9 | 700 |
| Norwich | 85 | 201 |
| Ohio Trap Rock | 1 | 1801 |
| Mass | 5 | |

Mr. HILL informs us that the mines on Kewenaw Point, as a general thing, are looking exceedingly well, and that their product the present season will also show a handsome increase.

The *Central* he is quite sanguine will ship 100 tons, which will be very nearly double the last year's yield. Mr. H. estimates the product for 1856, of the two districts, at from 5,500 to 6,000 tons.

The *Toltec*, we are informed, is improving very much. They have labored under many disadvantages this winter on account of the difficulty experienced in getting their hoisting engine in place and condition for working; the severe cold weather preventing the mechanics from working out of doors. But now that these difficulties are overcome and the engine in fine working order, we may reasonably expect a healthy improvement at this location.

The mines on the *Evergreen Bluff* are all looking well, and will help very materially to swell the amount of mineral raised this year.

We are informed by Mr. BUZZO the agent, that the *Ridge* produced during the month of February 7 tons of copper. The total expenses for the same time, did not exceed $2,000.

The *Adventure* raised during the same month 20 tons.

The *Aztec*, one of the mines situated on the Evergreen Bluff, has produced since the close of navigation, with an average force of only six miners, over fifty-four tons of copper.

The *Mass* mine contemplate increasing their force from *four* miners to *twelve*, within a few days. We learn that it is the intention of the proprietors to commence the sinking of a new shaft. The sinking on this location has been very difficult, owing to the amount of mineral encountered in descending, several large masses being already exposed in the bottom of the shaft, which it will take some time to uncover.

At the *Norwich* several large masses are exposed, and notwithstanding the small force they have been obliged to work, on account of their limited amount of supplies, the mine still promises a handsome product.

A correspondent of the Chicago *Democratic Press*, writes thus from Eagle Harbor:

"Col. Whittlesey, in his able and economical management of the Eagle River Mine, is meeting with deserved success. In the two galleries going south, small masses, barrel and rich stamp work, are constantly met with. That mine will be able to make a handsome shipment of copper on the opening of navigation. They are now working within a few feet of the south boundary of the Hill Mine, belonging to the Garden City, and on the same vein, just under and south of the crystalline trap. The Garden City own one mile in extent of this productive vein, and it is to be hoped that the earliest opportunity will be improved in exhuming its resources. The Phœnix Company on the north, and the Eagle River on the south, having proved the productiveness of this Company's vein, it will be an anomaly in mining if this does not prove one of the best mining ventures of the country."

### MINNESOTA COMPANY.

The report of the Minnesota Mining Company gives the product of 1855, $549,376; expenditures, $380,932 69. Dividend of $10 on 20,000 shares, $200,000. Surplus for the year's business, $68,944. Total surplus assets, March 1, 1856, $190,750 85, including metal at the mine and in hand, and exclusive of every liability. The average product of 1855 was 119½ tons per month, against 63½ tons for 1854, an increase of 88 per cent. The product of January and February, 1856, shows an increase of 78 per cent. over that of the same months of 1855, and an increase of 31 per cent. over the average monthly product of 1855. Of the 1,592¼ tons produced in 1855, 1,173½ tons were actually received and sold. The remaining 418¾ tons, with the product of January, February, March and April, 1856, will give to the company 1,000 tons at least on the opening of navigation. At present prices this large quantity is worth in the market $420,000. The following figures give its past history. The mine has cost but $66,000 to its proprietors, in addition to the sums obtained from its product prior to the payment of dividends. It was commenced in 1848, and it paid its first dividend from the earnings of 1852. Since then its dividends have been $380,000. The net value of the metal raised from it since 1848 is $1,380,700.

### EXPORTS FROM LAKE SUPERIOR IN 1855.

We are indebted to Mr. S. W. Hill, of Eagle Harbor, for the following:

| | |
|---|---|
| Copper, 4,755¼ tons, at 2,000 lbs. to the ton. Produce in fine copper 3,828 tons, 1,750 lbs.; valued at $540 per ton. Total, . . . . | $1,797,862 50 |
| Iron in blooms and Iron ore; valued at . . . . . | 125,000 00 |
| Fish, . . . . . | 20,000 00 |
| Total, | $1,942,862 50 |

### PHŒNIX COPPER MINE.

Mr. J. A. Dupee, in behalf of O. A. Farwell, Esq., President of the Phœnix Copper Company, presented some specimens of native copper from the Company's location at Kewenaw Point, Lake Superior. It is well known that the copper veins of that district are usually found in a direction nearly north and south. The specimens now exhibited were taken from what is called in that neighborhood the "scoriaceous or ash bed." This bed of 150 to to 250 feet in thickness, lies parallel with the geological formation, and has been traced from east to west about nine miles. It has long been known as containing copper. So early as 1844 considerable quantities were taken from it, but it was not ascertained to be worth working until 1854. Considerable attention to its value has been paid by the Copper Falls Company, and, it is understood, with prospect of pecuniary success.

Although frequently called an east or west *vein*, this deposit has not been considered by miners, technically, as such. Mr. Hill, in his annual report to the Phœnix Company, January, 1855, page 8, speaks of it as "holding copper, *intermixed* with the rock, *and not in a vein.*" A true vein has at last *been discovered* in this bed. Mr. Butler, Superintendent, writes to the Presi-

dent of the Phœnix Company, under date of the 16th November, that he has opened a well walled vein, running east and west, in the ash bed, 30 to 40 feet in width, carrying rich stamp work. Aside from any interest this may excite as a mining adventure, the discovery is one of great scientific interest. Hitherto the formation of Kewenaw Point has been regarded, so far as its cupriferous deposits were concerned, as very different from the districts of Portage Lake and Ontonagon. In those places the metallic veins are found, with a single exception, at the Quincy Mine, P. L., running *with* the formation, while at Kewenaw Point, until this year, the veins were supposed, invariably, to cross the formation at nearly right angles.

Mr. Dupee called upon Dr. C. T. Jackson for his views with regard to this mineral deposit on Eagle River.

Dr. Jackson then stated, that when he first called public attention to the Native Copper Mines on Lake Superior, in 1844, he made a full survey of the whole mining districts on Eagle River, and at Copper Falls, and had published in his reports to the Lake Superior and Copper Falls Mining Companies, very full descriptions of their respective mining "countries," and of the copper and silver veins included in the rocks. On reference to his first report, in 1844, it will be found that this scoriaceous or "ash bed," as seen on the margin of Eagle River, is described as exhibiting one wall, while, for the distance of 90 feet at right angles to it, the rock is impregnated with particles of native copper and silver, which are most abundant in the "ash bed," there called the "rotten rock." The other vale of this bed was not then found, and he was glad to learn that it had been discovered by the miners. Regular veins had also been found in this same scoriaceous trap-rock, and at the time the Lake Superior company stopped work, through bad counsels, there was a vein with well defined walls, and rich in copper and silver at the bottom of their tunnel under the river. Copper mining, at that day, was so little understood by the early adventurers, and so many difficulties stood in their way in an unbroken wilderness, that the first mining company abandoned their mines before they had fairly commenced regular works. The Phœnix Company, having purchased the property, are now mining with greater advantages, and it is believed with fair prospects of ultimate success. The ash bed, mentioned by Mr. Dupee, is a comparatively soft scoria, or rotten amygdaloid, formed by the mixture of molten trap-rocks and fine sandstone, which have been, as it were, melted together into a very spongy kind of scoria, the aqueous vapor having rendered it remarkably vesicular. The amygdaloidal and scoriaceous beds of trap rock, occur in alternate layers with coarse conglomerate and fine red sandstone strata, appearing as if immense sheets of the molten trap had been poured out at different times through a fissure, and spread over the materials of the sandstone, and conglomerate at the bottom of the sea, thus producing alternate beds of these rocks.

In the bed of Eagle River, below the Phœnix mines, Dr. Jackson's assistant, George O. Barnes, had found no less than eleven distinct beds of sandstone and conglomerate alternating with the trap; and Dr. Jackson had previously described six of these alternations in his notes of the survey of the mining district of Copper Falls. It is true that there are cupriferous beds running with the "County" or parallel to the trend of the trappean range, and of the sandstone strata, which have a course E. N. E. and W. S. W., and that there are also crossing veins, which traverse these at right angles, and are generally rich in metallic lodes, and have well defined walls and vein stones well characterized, phrenite being the most common of the out-cropping wall stone of the native copper veins, though Leonhardite, Laumonite, Calcareous Spar, also occur in a similar manner in the mines; while Analcime, Apophylite, Mesotype, and Chabasie, are common accompanying minerals. Toward the Ontonagon, and also in the Isle Royale, Epidote is the most common vein stone, and even forms layer-beds filled with small irregular grains of copper which often amount to eight per cent of the mass. It is a curious and interesting fact that, although a vein fissure traverses both sand stone and trap

rocks, that the only metalliferous portion of the vein is that which traverses the trap. This Dr. Jackson explained as the result of chemical action of protoxide of iron in the trap rock which decomposed the vapor of chloride of copper as it rushed from the interior of the earth through the crevices, if, as is possible, these wonderful Native Copper bodies are the products of sublimation and of galvanic segregation of the metal from vapor.—*Boston Natural Hist. Society.*

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COST OF MINING, STAMPS, AND WASHING ON LAKE SUPERIOR.

A correspondent of the *Miner* furnishes some very important statements relative to the expense of mining operations in that region. He says:—

About a year since, at the request of persons concerned in copper mines, I made some estimates upon the cost of working mines at Lake Superior. This paper has gone from my possession, but the memoranda upon which it is based remain. I propose to furnish you for publication, parts of the information collected. We have not, as they have in Cornwall, the assistance of government agents in collecting statistics of mines; so that whoever undertakes it must rely upon the voluntary reports of directors and managers to stockholders, and upon the courtesy of agents at the works.

Moreover, the Lake Superior mines are of so recent origin that even if we had every thing in detail, such statements would not cover a sufficient length of time to give a good average.

What I have to offer is not given as perfect, but as the best the nature of the case allows. The reader will also remember, that it is only to the early part of the year 1855 that my estimates are carried. My object was, to be able if possible to give the mean or average cost of getting out and carrying through the stamp mill *a ton of vein matter.*

When this can be fairly done, we know at once what per centage of copper will meet cost, and pay a profit.

*Mr. Hill's statement* of the cost of running and of the duty of 24 heads, at *Copper Falls Mine*, March 1855: Rock pulverized per day, 27 tons of 2000 pounds.

| | |
|---|---|
| 2 engineers per day | $3 08 |
| 2 firemen " | 2 80 |
| 6 cords of wood | 10 00 |
| Oil for machinery, &c. | 2 00 |
| 4 men and 11 boys in the stamp house | 18 65 |
| Hauling ore 35 cents per ton | 9 45 |
| Breaking rock 18 cts per ton | 8 51 |
| Running cost per day | $43 99 |
| Running cost per ton | 1 63 |
| No. of men and boys about machinery, floors and stamps | 25 |

At the same time, the engine carried a saw which Mr. Hill considers equal to 16 heads. The rock was not calcined. Apply all the power of the engine to the stamps, it would drive 48 heads, and the reduction should be 27 cents per ton on the cost of stamping and washing.

*Capt. Paull's statement* of the daily expenses of stamping and washing at the *North American* Mine, March 1855: No. of stamps, 12. Rock crushed per day, 20 tons—calcined.

| | |
|---|---|
| 2 engineers per day | $3 46 |
| 2 firemen per day | 2 80 |
| 2 men tending stamps | 2 52 |
| 4 men on washing floors | 6 17 |
| 2 men wheeling out sand | 2 00 |
| 9 boys on the floors | 5 12 |
| 2 boys at stamps | 1 46 |
| 4 cords of wood | 6 00 |
| Calcining ore, including teaming and wood at 20 cents per ton | 4 00 |
| Breaking rock, at 10 cents | 2 00 |
| Hauling rock, at 15 cents | 3 00 |
| Oil per day | 2 00 |
| Running cost per day | $40 03 |
| Running cost per ton | 2 00 |
| No. of men and boys about engine, floors and stamps | 20 |

The engine is capable of driving 40 heads of stamps. Capt. Paull says of this statement, that they were at the time working at great disadvantage, for want of men, and proper arrangements on the floors; and that by using all the power of the engine upon stamps, and working with proper fixtures, the running expenses would diminish *one-third;* that is to $1 84 per ton. Mr. Hill and Capt. Paull agree that the true way to cheapen the pulverizing and washing of rock is to work on a *larger scale.*

In 1854, at the North Western Mine, running 8 heads, there was required 2 engines—3 men breaking rock, and 12 men and boys about the mill, making 17 in all. The engine consumes 7 cords of wood, and at the same time carries a saw.

Capt. Pethrick, now of the Copper Falls Mine, was the first to keep a daily account of work done, and of current expenses; and this was done at the North West Mine in 1853. His results for six months are as follows:—

| | |
|---|---|
| Tramming to kiln, per ton | $0 06¼ |
| Calcining all told, per ton | 0 85 |
| Stamps and engine, per ton | 0 76 |
| Washing floors, per ton | 0 68¼ |
| Making all told | $1 86 |

These authorities, therefore, give the following results for the cost of taking up rock at the shaft, and passing it through the stamp mill and floors:

| | | | |
|---|---|---|---|
| Copper Falls, per ton | $1 68 | On a large scale | $1 36 |
| N. American, per ton | 2 00 | On a large scale | 1 84 |
| North West, per ton | 1 86 | On a large scale | —. |

At Copper Falls, the waste sand is cleared out by the stream of water; and the mineral rock was not calcined; but the hauling exceeds either of the other mines, on account of the distance from the shaft to the mill. If we take out the calcining and hauling, from the reduced estimate at the N. American, the current cost of stamping and washing is eighty-nine cents per ton; and at Copper Falls after hauling and breaking is deducted, 88 cents.

The cost and repair of machinery have not yet been introduced.

*Performance of Stamps on Point Keweenaw.*

| Name of mine. | No. of stamp heads. | No. of tons pulverised per month. | No. of tons per head per day of 24 h. |
|---|---|---|---|
| North West | 12 | 510½ | 1,93 |
| North Western | 8 | 390 | 1,82 |
| North American old work | 8 | 220 | 1,25 |
| North American new work | 12 | 480 | 1,66 |
| Copper Falls | 24 | 648 | 1.12 |
| Isle Royal | 16 | 450 | 1,22 |
| Average duty | | | 1,50 |

The rock is all calcined except at Copper Falls. Calling *one and one-half* tons per head the average duty, a mill of 48 heads, working 23 days in a month, will crush 17,112 tons in a year.

Such a mill can now be built for $25,000, unless the distance from navigation is great and the road difficult.

Allowing for depreciation, repairs and interest, twenty per cent., which is a large margin, this item would be $5000, and amount to *twenty-nine* cents a ton. Adding 29 cents to the running costs, and we have one dollar, and eighteen cents, as a close approximation to the expenses of working up and washing a ton of vein matter taken at the mouth of the shaft.

If an account of running expenses had been kept at the mines from the time their stamp mills were started, the result would have been much more satisfactory; but we have enough to allow of a close approximation.

Having made an estimate for stamping and washing,—based upon the best information we possess, the next point to be considered is the expense of *opening the ground.* In this I shall include the cost of getting the mineral to the surface where the trammer takes it for the stamps.

In March 1855, at the North American Mine, by Capt. Paull's statement, *forty-four* miners in the stopes kept the mill going, that is, they sent to the surface four hundred and eighty tons per month. The expense per man was $40 all told, or $1760 for 44 men.

The mass and barrel work taken out by them I do not notice here, because my object is to get at the cost and value of *stamp work* alone. The cost of filling, landing, hoisting and pumping was three hundred and thirty-six dollars per month.

A large portion of the current surface work about a mine is accounted for in the item of wood, and forms part of the running expense of the engines where it is already accounted for.

How to apportion the other expenses so as to apply them fairly to the mineral raised annually or monthly, is not so easy. Shafts and galleries remain after the stopes are taken out, as a part of the permanent works of the mine for future use.

The machinery is also a permanent improvement, but of a kind that depreciates rapidly. Buildings, roads and fences, are necessary. They cost money and need continual repair. The amount of capital invested in all these works is large, not far as we shall see from 200,000 dollars. Before a mine can be said to be fairly opened and proven, from 1000 to 1500 feet of shafts and 3500 to 5000 feet of galleries, adits and levels, must be made. The mine will be producing something before so much work is done; but this product goes to form part of the capital.

We have the means of giving a good average of the *mining* cost of such works, which I gather from the Reports of Companies.

*Contract Prices on Lake Superior.*

| Name of mine. | Cost of shafts per foot. | Cost of levels per foot. | Cost of stopes per fathom. |
|---|---|---|---|
| Forest 1853 | $11 12 | $7 84 | $24 12 |
| Copper Falls 1853 | 14 04 | 5 54 | 14 26 |
| Toltec 1853 | 11 50 | 8 00 | |
| Toltec 1854 | 10 67 | 7 70 | 19 12 |
| North Western 1854 | 18 00 | 6 00 | 18 00 |
| Cliff 1854 | 17 00 | 10 10 | 23 11 |
| Average price. | 13 72 | 7 53 | 19 72 |
| Price in Cornwall. | 7 00 | 3 50 | 12 00 |

Taking the extreme outside of 1500 feet of shafts and 5000 feet of level, the mine work would at these prices cost sixty thousand dollars. In bringing a mine to this state the surface expenses for roads, buildings, timber, whims and labor about the shafts, will be about as much more, or $120,000. To this add a winding and a pumping engine, set up at $50,000, and we have a permanent investment of $170,000. The stamping engine is included in the estimate for stamp work. The above calculations may be compared with the amount expended at the following mines to March, 1855 :—

| | |
|---|---|
| North Western | $182,000 |
| North American | 235,000 |
| Cliff (up to paying point) | 111,000 |
| Copper Falls | 280,000 |
| Isle Royal | 182,000 |
| Toltec | 220,000 |
| Norwich | 140,000 |
| Mean | $178 571 |

If we allow $200,000 as the capital sum invested, the interest at *seven per cent.* is $14,000 per annum, which on 17,112 tons of crushed vein matter is eighty-two cents per ton for the interest charge.

Less capital will undoubtedly open a mine hereafter. To bring the cost of stoping per fathom to bear upon the rock reckoned in tons as it goes to the stamps, the thickness of the vein must be taken into account. For ground that does not carry large masses, the above average of $19 72 per fathom running measure is evidently too high. At $15 per fathom the contract cost per ton of 2000 lbs. for veins of different dimensions is here given :—

| Thickness of vein. | No. of tons per fathom. | Cost of stoping per ton. |
|---|---|---|
| 2 feet | 6·48 | $3 55 |
| 1½ | 4·86 | 4 72 |
| 1 | 3·24 | 7 09 |
| ½ | 1·62 | 14 20 |

The weight of vein matter is reckoned for stamp work, and with an average of three per cent. copper. Assuming a vein to be 18 inches thick upon an average and to produce stamp work alone, the cost of carrying a ton of rock through all the processes will not be far from the figures given below. They are fixed for a mine worked on a large scale, under the present facilities of transportation and pulverising, at 17,112 tons a year.

| | |
|---|---|
| Opening the mine,—contract work | $1 29 |
| Surface expenses, depreciation and smelting | 1 29 |
| Superintendence and clerk hire | 0 27 |
| Interest account | 0 82 |
| Stamping, washing, tramming and burning | 1 80 |
| Pumping, hoisting, wheeling and tanding | 0 50 |
| Stoping per ton contract price | 4 72 |
| Total cost per ton | $10 19 |

These estimates may be tested in part by the cost of working at the Cliff mine.

According to the Report of 1854 the Company had expended for all purposes from the commencement of the enterprise up to the close of that fiscal year, 948,839 dollars—of this $29,443 was paid for real estate. If we assume as above, $200,000 as the capital invested in permanent improvements and opening the mine, the stock or investment would be represented by $229,443. The assets of the Co. are given at $202,288. Deducting this and the capital stock from the sum total of expenditures, there remains $517,108 chargeable to the current running expenses of the mine for all the previous years.

Mr. Park, the attentive and obliging clerk of the Co. at the work, calculates the number of fathoms of ground stoped up to the date of the Report of 1854, at nine thousand one hundred and eighty-eight.

The running expense per fathom is therefore *fifty-five and a half* dollars, and as the vein averages *one foot and a half* in thickness if it carried stamp stuff only, there would be 84.06 to the fathom. The current expense per ton of vein matter from its position in site in the mine through all the processes and manipulations till the product appears in the shape of ingot copper, is $11 33. In this case I have put upon the stamp work the extra expense of taking down and cutting up masses which adds materially to the cost per fathom.

In the same report it is stated that the expenses of the year then closed were for all purposes $181,869, of which there remained $37,969 of supplies on hand. A winding engine had also been put up the same year, which must have cost by the time it was ready to run $20,000, and some buildings were erected at the mine in addition to the engine house. The permanent improvements and supplies on hand should not be charged to the running ex-

penses of the mine for that year. It is not easy to say what the exact sum was; but it would seem that $130,000 is not far from the truth. The mine produced 547½ tons of washed ore which at 50 per cent. would produce 273¾ tons of ingot copper, worth, at 500 dollars per ton, $136,875. Thus it appears that the stamp work alone paid current expenses. C. W.

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# JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

### THE WILLISTON SILVER LEAD MINE.

From a Report by the officers of this company we take the following statement:

This valuable mineral property is situate in the town of Southampton, Mass., and embraces an area of over 200 acres of land, of nearly half a mile in length. This is traversed by an immense lode, or vein of silver lead ore, estimated at 14 feet in thickness, and yielding from 1 to 8 tons per fathom (6 feet); its average is calculated at 1½ tons per fathom, and worth $150. Various pits and shallow shafts have been sunk on the vein, and the ore is found increasing in quantity and quality as it goes down. At 10 feet from surface the leading vein of the lode is 2 inches thick; at 30 feet, 14 inches; and at 60 feet, 20 inches of nearly solid silver lead ore. The point of drainage is in the Loudville Valley, 180 feet below; the workings there belonging to the Hampshire Mining Company have been more extensive; the lode is found at this depth to be 16 feet thick, and composed of four distinct veins of ore, bearing quartz, and in a soft, decomposed rock, very easy to work, it has been found to produce 3 tons of ore to the fathom, and found holding down very productive below the river or valley level.

Above this level there is in the Williston Mine over 6,000 fathoms of ore ground, which, yielding on an average 1½ tons of ore per fathom, gives 9000 tons; and, valued at the present market price of lead ore, will produce $900,000; below this point the mine will increase in value. The minerals of this mine have been purchased in perpetuity; there are, therefore, no leases, conditions, rents, dues, or royalties to encumber the property, which is a thing of great importance to the Company.

The property is within two and a half miles of the canal of the Northampton and New Haven Railroad; consequently the cost of transportation of the ore to the shipping port or smelting works of New Haven, will be of comparatively small amount.

The purchase of the mine has been effected for the low sum of $33,000, and on the most advantageous terms for the Company, the owners having agreed to take payment by installments running over a term of three years from date of transfer. The works on the mine will be prosecuted with vigor, and conducted on the most improved system of modern English mining. It is estimated that not more than five dollars per share will be required to put the mine down 30 fathoms (180 feet) deep, and erect all the necessary machinery. On attaining this point the produce will be sufficient to enable the managers to declare a dividend of something like 15 per cent., which will be increased as the mine is developed. In sinking the engine shaft and opening the levels preparatory to working away the ore ground, a profit of over *$20,000 may* be expected to accrue from the sale of ore thus extracted. Sales

of ore will commence within nine months from the time of commencement, and it will be the especial object of the managers to make the first dividend, if possible, within the first fifteen months.

The financial affairs of the Company will be conducted with the closest economy, and no debts will be permitted to remain unpaid longer than three months.

General meetings of the Stockholders will be held every three months, at which a full report, both financial and progressive, will be laid before the meeting; and further, to afford every facility to shareholders to become acquainted with their investment, a printed circular will be issued quarterly, containing the minutes of the meetings, the amount of expenditure, and a descriptive report of the progress of the mine. This will be found very convenient to those who cannot attend the general meetings. The organization of this Company is not for the purposes of speculation; the promoters, who are all men connected with the mercantile and trading community of the New England States, intend it to be carried out in a bona-fide and legitimate manner, and they recommend it to the public as a promising undertaking, and a fair medium for investment.

Reports, descriptive of the property, with an estimate of probable cost and returns, have been made by Prof. B. Silliman, jr., of New Haven, Mr. C. S. Richardson, mining engineer from the great Cornish mines of England, and several captains of American mines, in the united judgment of whom the Directors have every reason to place the most implicit confidence.

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### MORGAN SILVER LEAD AND COPPER MINE.

From the Report of Prof. C. U. Shepard we learn the following facts respecting this interesting mine:

The first observation that led to this important discovery was made in April, 1854, by Mr. Hiram Lockhart, a farmer of the neighborhood, who was then engaged in the search for gold. His attention was arrested by heavy particles of a silvery ore found in the soil he was panning for this metal. This led to a farther digging at the place where the soil was collected, when the discovery of the ore, *in place*, was effected. A more thorough exploration of the locality was now made by regular miners. Mr. Newton Manross, of Connecticut, a graduate of the university of Göttingen, and a pupil of Professor Woehler, was employed in the month of December to make a survey of the property. His report is as follows:—

"*The Morgan Mine.*—This property is situated in Spartanburg District, eighteen miles north-east of the court-house. It is connected by good roads, with the navigable waters of Broad River, distant twelve miles. The tract embraces 505 acres of moderately hilly land, well watered and timbered; and in good state of cultivation. The accompanying map will illustrate the portion of the vein upon the property. It was first opened at the point marked 1, where a shaft has been sunk about 18 feet, and a level driven some 20 feet upon it. The vein varies from two to two and a half feet in width, and consists mainly of quartz and oxide of iron or gossan. Its course is north, 35° east, with a dip to the south-east of about 70°. The inclosing rock is a micaceous slate, having the same strike and dip as the vein. The walls are well defined, striated, glazed, and polished; and in these respects, resemble so closely those of true mineral veins, as to justify the opinion that this vein belongs to that class, notwithstanding its coincidence in dip and direction, with the inclosing strata. The mineral contents of the vein are,—first, galena, or sulphuret of lead, in masses of from 1 to 50 lbs.,—secondly, phosphate of lead, coating cavities, and forming small veins,—thirdly, carbonate of lead, in crystals and veins, often constituting a rich ore,—fourthly, stones of copper pyrites of 20 to 30 lbs., with small quantities of green carbonate of copper. Of these ores, the galena is far the most abundant; the other ores of lead may

be expected to disappear at no great depth; while the copper will increase in quantity. The galena is highly argentiferous. Twenty-four pounds of the undressed ore yielded in the crucible, 14 lbs. of fine lead; and 4 lbs. of this metal afforded 8 pennyweights and 9 grains of silver,—equal to 84 ounces for 2,000 lbs. of metal; or, 49 ounces for 2,000 lbs. of ore. Such unusual richness in silver, renders this lead ore peculiarly valuable; and its value is fortunately not diminished by the presence of zinc, arsenic, antimony, or any of those substances which often render rich ores almost worthless. The richness of these ores, their freedom from impurities, and their abundance in the vein, leave no other question unsettled regarding the prospective value of this mine, than the extent of a workable vein. The vein has as yet been penetrated downwards only about 18 feet. Thus far it retains its full width, and its walls become constantly firmer and better defined. From this fact, its persistence to great depth may fairly be inferred. The only change which can be perceived in the metallic contents of the vein in descending, is the greater abundance of the copper ore. This mineral promises to add still further to the value of the vein, when a depth shall be reached at which copper has not been removed by decomposition.

In regard to the linear extent of the vein, the following facts will speak for themselves.—To the southwest of 1, the land is low and marshy, and affords no opportunity for tracing the vein in that direction; but, to the north, following the course of the vein, north, 35° east, it may be traced at intervals, by its outcrops of ferruginous quartz, over a distance of 102 rods. Here, at 2, a pit has been sunk, a few feet in depth, which reveals a vein, identical in width, dip, direction, and mineral contents, with the vein at 1. The conclusion is unavoidable, that these two points are upon the same vein, and of course, that it is continuous over the intervening distance. With these facts, I do not hesitate to pronounce this place one of great promise, and well worthy of a thorough trial. Whether the argentiferous galena shall continue to be the prevailing ore, or, as is not unlikely, shall give place to copper in descending, matters little to its ultimate value. In either case, the abundance of valuable mineral, within the present trifling distance of the surface, gives ample promise of rich returns below.

In March, of the present year, I found the explorations not much extended, since the date of the above report. The greatest depth to which the vein has been penetrated was only about 22 feet; but an adit, at water level, had been carried in (to the north-east) upon the course of the vein for a distance of 70 feet. In the progress of this working, it has been discovered, that the ore-bearing portion of the vein, or technically speaking, the lode, ceases at a distance of 40 feet from the shaft,—there taking a downcast, or dip to the north-east, apparently of 70°. The top of this lode has been traced 20 feet south-west from the shaft, beyond which point it was impossible to follow it, in consequence of the presence of water; though it was ascertained that this was not the bounding limit, or termination of the orey ground. A proof shaft had been commenced at a distance of about 20 feet to the south-east of the vein shaft, and sunk already to the depth of 30 feet. It is thus expected to cut the lode at a depth of about 100 feet from the top of the ground. The rock through which they are here cutting, is different from that forming the upper wall of the vein. It is a hornblendic rock, much seamed with epidote. I find that in the present condition of the mine, the bounding walls of the vein do not correspond with Mr. Manross's description. The under wall, or north-western side rock, is not slate, like that contiguous to the upper side of the vein, but a fine grained feldspathic granite. This is a fact which establishes beyond a doubt, the character of the deposit as being *a true metallic vein*, instead of a mere interlaminated seam or bed, as might have been supposed, had the embracing rock being slate upon both sides. Besides, it is always taken as a sign of mineral wealth, when a vein occurs in proximity with dissimilar rocks, and especially when one of them is a granite of the *variety here found*. The width of the vein is accurately laid down by Mr.

Manross. Its walls are smooth, in like manner with the surface of the contiguous rock on both of its sides. The galena is most abundant on the under or granite side of the vein, where at one spot, it may be seen in a continuous rib of several feet in extent, with an average thickness of eight inches. It is more prone, however, to occur in somewhat isolated bunches upon the under side of the vein, some of which are fully a foot in thickness. A heap containing many tons of the richer portions of the lode, may be seen lying contiguous to the shaft, which requires only a casual inspection to convince the experienced observer, that it came from a metallic vein of the very highest promise. It is made up of lumps of pure galena, some of which weigh more than 60 lbs., of masses of carbonate of lead, (often cellular and drusy), more or less intermixed with white crystals of sulphate of lead, and green crystals of phosphate of lead, (the latter occurs also, quite extensively coating seams and cavities of the quartz), and, finally, of large stones of hydrated oxyd of iron and quartz, (gossan), through which are diffused seams and masses of a compact yellow copper pyrites, (rarely also attended by fibres of the green carbonate of copper). The whole taken together constitutes a mineral produce, that I have nowhere seen equalled by that of any vein at its outcrop. Indeed, it would be considered adequate to establish the character of a mine, if coming from a depth of many hundred feet below the surface. The vein is distinctly traceable up the hill to the north-east, and passes over somewhat elevated ground for the distance of 102 rods to 2, where a second digging (of a few feet in depth only) has been made, but where the same ores are visible, as at the spot already described. Beyond this point no explorations have been made; but the tract would comprehend a prolongation of the vein for a distance of 300 yards in this direction, while in that to the south-west of the shaft, it would include the vein, should it be found to run three quarters of a mile from that point.

The geological character of the formation contiguous to the vein on the north-west, is highly favorable to the existence of a rich mineral deposit at this mine. Immediately adjoining is a region of slate, about three-quarters of a mile in width, embracing auriferous quartz veins, which have everywhere given rise to more or less valuable alluvial deposits of gold, some of which have been worked quite up to the Morgan Silver-Lead Vein, and are said in all to have afforded a return of one hundred thousand dollars. But the most significant circumstance, perhaps, connected with this gold formation, is the fact, that the gold yielded by it, unlike that from any other section of the Southern States, is highly *argentiferous*, its value at the Mint being only 70 cents the pennyweight, in consequence of the large alloy of silver. It may be added also, that this gold-bearing formation is the same band or layer of rock, which a few miles further to the south-west contains the valuable gold mines of Spartanburg and Union Districts. To the gold formation, next succeed the talcose slate and limestone, each, perhaps, somewhat less than half a mile in thickness, both which also traverse the Swedish Iron Company's tract, in their prolongation to the north-east. Galena and the salts of Lead derived therefrom, through atmospheric agency, form by far the preponderating portion of the lode, although the copper ore occurs in masses of such purity and size, as to leave little doubt that the vein in some portion of its extent, or that cross veins with which it is probaby connected, will afford at a proper depth, a valuable produce in this metal. The galena has yielded me 32 ounces of silver to the ton of 2000 lbs.; and what greatly increases its value for this precious metal, is the fact, that *it is not accompanied by zinc*, whose presence and intimate mixture with silver-leads so often deprive them of their whole value. The copper ore, also, is of the most promising character, being made up of a very massive and pure copper pyrites, which contains at least 28 per cent. of metallic copper. Its aspect reminds me of the ore raised from great depths, rather than from the mere surface of a vein. Specimens of both grey and purple copper are said to have been met with at the locality, but none of them came under my notice.

It is of some importance in the economical working of the mine, that it is immediately contiguous to a never-failing stream of water, which orginates two miles distant, in the celebrated limestone spring, and which, soon after its outburst, has power sufficient to carry an ordinary grist-mill. This stream crosses the vein within 50 yards of the workings, and has a fall just above of 18 feet. By the construction of a dam 50 rods above the mine, and cutting a race-way through grounds quite favorable to the undertaking, the power is capable of being very conveniently applied directly at the works, not only for the separation of the ores, but for pumping water and raising the produce of the mine. When we consider, therefore, the size, extent in length of the vein, its richness at the surface, and the mine-like character of the lode, together with its favorable position for working: and further, when we bear in mind that the whole work is but of a few months' development, we are compelled to regard the Morgan Silver-Lead and Copper Mine, as one of the most inviting speculations of the kind, that has thus far offered itself in the United States.

P.S. Since the date of the foregoing report of Professor Shepard, a letter has been received from Mr. Hiram Lockhart, in whose charge the mine now is, by which we learn that an adit had been taken in, to the vein from the proof shaft, (see p. 872), at a depth of 88 feet, and that they found it three and a half feet across, and very rich. Mr. Trevellan, an English miner, terms it a "*Bully Vein.*"

*Assay of the Ore.*—The two following assays of lead ore have been made in this country, upon average samples of the ore. The first is by H. L. Pattinson, Esq., of Newcastle-on-Tyne; the second by Mr. William Baker, of Sheffield.

| | | | | *Per Ton of Ore.* | | |
|---|---|---|---|---|---|---|
| First . | Lead | 76.2 p. c. | Silver . | 12oz. | 8dwts. | 0grs. |
| Second . | Do | 79.0 p. c. | Do . | 28 | 10 | 8 |

The following opinion of the Morgan Silver-Lead and Copper Mine, has been obligingly communicated by William Hobson, Esq., of Sheffield, England; a gentleman whose judgment in matters of this kind is much respected not only in this country but in the United States.

Grove Lodge, Sheffield, 22d May, 1855.

Dear Sir,—"A few days ago I had the pleasure of seeing Professor Shepard, who then laid before me a quantity of specimens of lead ores from the Morgan Silver-Lead, and Copper Mine, in South Carolina. They were very fine, and I am sure will give a large per centage of lead, and, I have no doubt also, a considerable quantity of silver. Specimens like these, taken, as I understand, from very near the surface, with all the other indications (as stated in a special report by Professor Shepard upon the mines), such as the geological formation, the size, regularity and continuity of the vein, &c., go to confirm the evidence, that it will make a rich mine; and, I think, with every probability, will continue a good one for a long time to come.

"I am, dear Sir, yours very truly,

"WM. HOBSON.

"To A. D. SELLECK, Esq.,
29 George Street, Hanover Square, London."

# QUARRIES AND CLAYS.

## ON HYDRAULIC LIMES, ARTIFICIAL STONES, AND DIFFERENT NOVEL APPLICATIONS OF SOLUBLE ALKALINE SILICATES. By M. Fr. Kuhlman.*

Intrusted, about the close of the year 1840, with some trials relative to some abundant efflorescence, which was formed on a perfectly new building, and which was considered to be due to the formation of nitre, I was soon convinced that the efflorescent salts were formed to a great extent of carbonate of soda, and that the lime which had been used (hydraulic lime, from the neighborhood of Tournay), was the cause of the efflorescence which had been observed. A closer examination soon taught me that all limes, and particularly hydraulic limes and natural cements, contained appreciable quantities of potash and soda.

*Theory of Hydraulic Limes.*—In a work which I had the honor of presenting to the Academy, at a meeting held on the 5th of May, 1841, I endeavored to explain the part which potash and soda might play in stones and cements, and I admitted that these alkalies served to bring the silica to the lime, and thus to form silicates, which, by means of the application of water, solidified a portion of the mass, producing the formation of a hydrate, analogous to that which takes place with plaster. I have pointed out since then to the Academy numerous facts as the basis of this theory, and that, among others, of the immediate change from fat lime to hydraulic lime, by simply treating with a solution of silicate of potash. If, after the burning of the limestone, potash is in contact with silica, the silicate which is formed must necessarily, re-act, and this can only take place as soon as the burnt lime is brought into contact with water.

I have greatly added to my experiments on this head, and I have established the fact that, with fat lime and silicate of potash, both of them pulverized and mixed in the proportion of 10 to 12 of silicate to 100 of lime, a lime can be obtained which shall have all the characteristics of hydraulic lime. If these substances are not well pulverized the reaction will be very incomplete, and an effect will subsequently be produced, bringing on disintegration. If from my former trials there results the possibility of converting a fat lime into an hydraulic mortar, by sprinkling it with a solution of an alkaline silicate, in my more recent trials, I have found a means of producing at once with a vitreous silicate and lime, hydraulic cements of any required degree of strength. This will enable us to form, at a reasonable expense, buildings to stand the action of water, in places where fat limes alone are now found. Powdered silicate of potash in some sort becomes an agent for producing this hydraulic property, of which future experiments will determine the value.

*Artificial Stones.*—Looking at the great affinity of lime for silica dissolved in potash, I was naturally led to examine the action of alkaline silicates on calcareous stones. Here I was still more fortunate, for the alkaline silicates became at once the means of a variety of applications of the highest utility. Let us look at what is said on this point in the *Comptes Rendus* of the Society's meetings.

"By mixing some powdered chalk in a solution of silicate of potash, a cement is obtained, which hardens slowly in the air, assuming a degree of stiffness, which, under certain circumstances, renders it applicable for the restoration of public monuments and the manufacture of moulded articles.

"Chalk, whether in an artificial paste or in its natural state, plunged into a solution of silicate of potash, takes up, even when cold, a quantity of silica, which may be increased considerably by exposing the chalk alternately to the

* From the Lond. Journal of the Society of Arts, July, 1855.

action of the siliceous solution and the air. The chalk assumes a smooth appearance, a compact grain, and a color more or less yellow, according as it is more or less impregnated with iron.

"Stone thus prepared is susceptible of a high polish. The hardness, which is at first but superficial, penetrates by degrees into the centre, even where there is considerable thickness. It appears capable of becoming of incontestable utility in the formation of works of sculpture and ornaments of the most delicate workmanship; for when the silicifying process—'*silicatization*'—has been effected on well-dried chalk, without which good results are not possible, the surface remains unalterable.

"Some attempts made to render this stone applicable for lithography give promise of great success.

"This method of converting soft limestone into siliceous limestone is likely to become a great acquisition in the art of building. Ornaments, unaffected by damp, and of great hardness, may thus be obtained at little cost; and, in many cases, a plaster made with a solution of silicate of potash, will preserve from subsequent decay ancient monuments formed of soft limestone. This same plaster may become of general application in those countries where, as in Champagne, chalk forms almost the only building material."

I have shown experimentally that one part of the silica from the silicate becomes separated by the action of the carbonic acid of the air, but that those parts of the silicate which have come into contact with a sufficient quantity of carbonate of lime pass into the state of silicate of lime. My work, presented to the Academy in 1841, pointed out numerous industrial purposes to which the impregnating of porous bodies of mineral substances might be applied, whether the objects operated upon were organic or inorganic. Considering these applications of the art as of the first importance in building, I have attempted to extend them, and I have just laid before the Academy a new series of observations.

*Harmonizing the Shades of the Silicified Stone.*—I have given the name of "*silicatization*" to this remarkable conversion of soft and porous limestone into siliceous and compact limestone. As the operation of this process to articles of sculpture and building materials, gives rise to a coloring very frequently so marked as to render the joinings more apparent and the veins more distinct, I have been compelled to seek a remedy for this objection.

There are two essential and general points to be met. Chalk walls are too white, while some kind of ferruginous limestones are too sombre in their shades. To obviate this inconvenience, I perform the *silicatization* of limestones which are too white with a double silicate of potash and magnesia. This is a vitreous substance, which forms a brown solution, and which when used in the process, causes a little oxide of manganese to be deposited in the artificial siliceous paste. Oxide of cobalt, too, will combine, though in very small quantities, with silicate of potash. Silica precipitated by a current of carbonic acid is of a brilliant azure blue. This silicate may be used in the treatment of white marbles.

When the shades of the stone are too decided, and that is the most common defect, I obtain good results by mixing in the silicate solution a small quantity of artificial sulphate of barytes, which, in penetrating the porous stone, whilst it forms a layer of silica, remains fixed, entering, as we shall see below, into a state of chemical combination. As regards the joints, they may be made with common cements, the shades of which may be rendered lighter by means of some white substances, but they may be still more entirely concealed with broken pieces of the stone itself mixed with silicate of potash, the whole being well pulverized previous to its use, and applied in a state of liquid paste.

*Coloring the Stone.*—In the course of my researches for giving to these silicified stones shades which would cause those portions of our buildings which had been submitted to this process to harmonize with those which had *not, I was led to* submit the stones to an actual dyeing process, by impregnat-

ing them in the first instance with certain metallic salts, which, by precipitation, would produce the required color.

Thus, impregnating the stones with salts of lead or copper, and afterwards bringing it into contact with sulphuretted hydrogen gas, or a solution of hydrosulphuret of ammonia, I obtain at will gray, black or brown shades; with salt of copper and ferrocyanide of potassium, I get shades of copper color, &c.

In the present case I have made an observation which, in a chemical point of view, is not devoid of interest.

I have stated that the porous limestones, when submitted at a boiling heat to solutions of metallic sulphates whose bases are insoluble in water, give rise during the whole reaction, to a disengagement of carbonic acid, and to the fixing in sufficient depths metallic oxides in intimate combination with sulphate of lime. When the metallic sulphates have a colored base, very beautiful tints of different and perfect shades are obtained. Thus, with sulphate of iron we get the production of a tint in red rust, more or less deep according as we operate with solutions of green vitriol more or less concentrated; with sulphate of copper the stone takes a magnificent green tint; with sulphate of manganese brown shades are obtained; with a mixture of sulphate of iron and sulphate of copper we get a chocolate color. I have, also, experimented with sulphates of nickel, chromium, cobalt, &c., and with mixtures of these sulphates.

The affinities which determine the reactions in question, are sufficiently powerful to cause the metallic oxides to be completely absorbed by the stone, so much so, that certain oxides, such as that of copper, for instance, entirely disappear from the solutions after boiling with an excess of chalk.

It is remarkable, that when in operating with mixtures of salts of copper and salts of iron or of manganese, the oxides of iron and manganese are the first to be thrown down.

When we operate with sulphates having a colorless base, such as sulphate of zinc, magnesia, or alumina, we equally obtain the precipitation from the oxide, and their penetration to a certain depth in the stone, with a disengagement of carbonic acid.

The bi-sulphate of lime gives analogous results.

In general, when we intend to use colored stones in buildings, &c., or to form mosaics, it will be found useful to increase their hardness by the silicifying process.

We may proceed in the same way with articles in shell, white coral, &c., in which the color may be produced by the same process, acting at different pressures.

I will conclude this head with an important observation, which is, that the double sulphates which are formed in penetrating the stone, make a body with it, and increase its hardness to such an extent, that when certain sulphates are employed, such as that of zinc, the silicifying process becomes unnecessary.

The editor of "*Cosmos*" adds, the process which has just been described, is likely to tend to the production of a great and new industry, splendid specimens of which are to be found in the Exposition Universelle, placed in the central gallery of the "*Annexe*," on the banks of the river, opposite the produce from the mines of Anzin. We shall examine these specimens with care, and give a detailed account of them when we treat of the section of the chemical arts. The display made by the celebrated chemist of Lille is one which deserves great attention.—*Cosmos.*

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VERD-ANTIQUE MARBLE.

Dr. Brewer requested Dr. Hayes to give the Society an account of the characters of the so-called Verd-Antique Marble, polished specimens of which were on the table.

Dr. Hayes remarked that, considerable interest having of late been attached to this material, as an ornamental stone, a committee of the Franklin Monument Association had requested him to examine it in relation to the action of atmospheric agents, purposing to adopt it as the base of the monument to be erected. It is well known that the extremes of heat and cold, the alternate dryness and humidity of our climate, soon deface and even disintegrate the less compact stones, leaving us but a limited number of materials, for ornamental workmanship exposed to the air. Ordinary marble suffers not only a superficial degradation of surface rapidly, but the new surface produced becomes a hot-bed for cryptogamous plants, which in turn disfigure it, and greatly aid further corrosion. The classic and beautiful sepulchral monument over the remains of Spurzheim, at Mount Auburn, exhibits the defacements due to combined action of lichen growth and moisture, while near by is a monument to one whose memory is revered by us, of imperfect bronze, also attesting the activity of atmospheric agents, when this metal is freely exposed to them.

The samples subjected to trials, were sawed, not polished surfaces; choice being made of the latter, because the natural flaws existing in the material, might become filled by the fine powders used in polishing.

The stone was first subjected to Braud's test, which, as is well known, quickly shows the unenduring character of sandstones, bricks, and some marbles. The activity of this test was increased, but under any mode of application, it failed to show any disposition in the material to absorb moisture, or disintegrate. Finally, hot diluted hydrochloric acid was applied, and the mineral was heated and immersed in it, without damage. The Quincy syenite and true granite will alone bear this test: the so called granite, which is truly gneiss, fails under its application. The enduring qualities of this stone being thus demonstrated, it may safely be used in permanent works, where its variegated shades of white and green will long preserve their polish and beauty.

This mineral has been called Verd-Antique marble, a name not only incorrect, but conveying a false conception of its value, in a technical sense, as verd-antique marble does not resist exposure to our atmosphere. The experiments alluded to above, proved that the white portions were not marble, and as these portions resisted chemical agents nearly as well as serpentine does, I was anxious to learn the composition of the whole. Dr. Brewer kindly furnished the specimens which he took from the quarry during a recent visit, parts of the collection he has now presented.

The analytical experiments were first made on the white portion of different masses, and the results established the interesting fact that this part is an anhydrous carbonate of magnesia, nearly pure.

The white part, often highly crystalline, can be separated from the masses, only in small fragments. It then presents a milk-white color, is translucent, the cleavage planes having a high lustre. Generally, it contains scaly talc, of a clear green color, or it is blended with a dark green serpentine.

The selected portions of the white parts, were used in the following determinations:—100 parts of the powder, lose humidity at 212° F., and at 450° F. the whole loss is 0.08. 100 parts of the dried powder, afford 47 parts of carbonic acid, as collected; the total loss of weight was equal to 48.80 parts. 100 parts of the dried powder consist of—

| | |
|---|---|
| Carbonic acid | 48.80 |
| Magnesia | 45.60 |
| Talc and a little silicic acid | 3.60 |
| Silicate protoxide iron | 1.96 |
| | 99.96 |

A more compact variety of the white mineral afforded—

| | |
|---|---|
| Moisture | 0.08 |
| Water, from hydrated rock | .98 |
| Carbonic acid | 47.16 |
| Magnesia | 44.94 |
| Talc lamina and silicic acid | 5.20 |
| Silicate of alumina | .64 |
| Protoxide of iron from silicate | 1.58 |
| | 99.88 |

The analysis of an average specimen, which exhibited the greenish black, light green and white colors intermixed, gave as its component parts—

| | |
|---|---|
| Moisture | 0.40 |
| Carbonate of Magnesia | 38.00 |
| Talc and serpentine | 61.60 |
| | 100.00 |

61.60 consisted of—

| | |
|---|---|
| Combined water | 6.44 |
| Silicic acid | 36.92 |
| Magnesia | 10.52 |
| Protoxide iron and manganese | 4.80 |
| Alumina | 2.06 |
| Chrome iron | .63 |
| | 61.37 |

The basis rock is, therefore, an indefinite mixture of serpentine and greenish white talc; with a silicate of alumina and protoxides of iron and manganese, which serves to render it compact, and probably imparts much of the green color.

Some specimens also contain actinolite, with talc firmly united so as to present a close texture and considerable resistance to fracture. The portion of chrome iron ore in crystalline grains, varies in different specimens; but it is never large enough to seriously interfere with the operations of sawing and polishing.

As carbonic acid is often found in the analyses of serpentine, a fact to which Prof. Wm. B. Rogers has recently called my attention, and which may be verified on some well-known varieties, it becomes apparent that this compound can hardly be classed as a single mineral, and we approach nearer the truth, when we consider it an aggregate of several distinct minerals, constituting a rock.—*Boston Nat. Hist. Society.*

## FULLER'S EARTH.

*Messrs. Editors.*—The supposed soap mine found in the Table Mountain, California, and recently mentioned in the SCIENTIFIC AMERICAN, is beyond doubt a bed of Fuller's earth. The very place to find it is among siliceous mountains, for its chief ingredient is fifty-three per cent. of impalpable silex, combined with from ten to twenty-four of alumina, twenty-four water, a small quantity of magnesia, and colored of a greenish brown with oxide of iron. Its being found in conjunction with pipe-clay is direct proof of its identity, for the best quality of pipe-clay contains nearly twenty per cent. more silex, twenty-five per cent. more alumina, and only ten of water.

To test Fuller's earth—it is first dried, put into a basin, and covered with water, when it will fall into a paste as soft as soft soap. It is also tested with an acid, and if any effervescence is observed it is unfit for the use of the fuller. It is used as a cleanser, to remove dirt, grease, and any remains of soap from cloth. It is a far better cleanser than soap, but produces the reverse effect in felting, as it leaves the pores of the wool and the thread more open than before it was used. All woollens colored in the piece, except for black, are first cleansed with Fuller's earth; and blues, and some other very dark colors, are cleaned with it. Fuller's earth, or pipe-clay, is used to make the brown soaps so much esteemed.—*Correspondent Scientific American.*

# MISCELLANIES.

### ARCHAMBAULT'S PORTABLE STEAM HOISTING AND PUMPING ENGINES.

In our advertising colums will be found a rough woodcut, and the advertisement of this valuable machine. The portable engine was first brought before the public in 1849, and as a testimonial of its merits from scientific men, it is only necessary to state that it took the first premium awarded by the Franklin Institute in 1851 and in 1853. The design of the machine is, labor-saving. In all the operations of hoisting, pile driving, pumping water, and other work, when powerful and rapid movement is necessary, it is found to be very useful and economical. Mr. Archambault has made over forty of these engines, and they are now in use in and around Philadelphia. These engines are not confined to any particular description of work. They have been used in different establishments for widely different purposes, and in every instance, when a fair trial has been given them, success has crowned each effort. The hoisting and pumping engines possess advantages over all others. They can be used as stationary engines if preferred, or easily made portable, which is a prominent feature in them. In moving them from one place to another the power acquired is easily attainable even in cities. The smaller ones can be readily drawn by two horses, and the larger ones by three or four horses. The expense attending them is but trifling. A small engine of from 6 to 12 horse power consumes from one and a half to two tons of coal per week, and an engine of from twelve to eighteen horse power only two or three tons of coal per week. The engines are constructed in such a manner as to admit of using either coal or wood for fuel. They are constructed on wheels three feet in diameter (with from four to six inch tread), with water boxes on the sides to feed the engine, which can be supplied from hydrants, wells, rivers, or small streams.

These machines require but one man to keep up steam and to attend to the brakes. They have been used for loading and unloading boats and vessels, hoisting coal and iron from mines; marble from quarries; stone and materials for bridges, driving flour and saw mills, and pumping water from marble quarries, gas works, and various other places. A gentleman in Maryland has used one upward of a year for driving his threshing machines and for other purposes on his farm, with admirable effect. Recently a five horse power machine, with one cylinder six inches in diameter, and two hoisting drums, was built for a firm in Philadelphia city for unloading coal boats. It was arranged on Locust-street wharf, and discharges twenty-four tons per hour.

It will be easily seen that the smaller engines are vastly superior to horse or manual power, in every particular of efficiency or economy, and the same holds good with regard to the larger machines, which, from the ease with which they can be moved from place to place, gives them a peculiar fitness for certain kinds of heavy work. The use of this engine is now rapidly increasing, and we learn that several of these have lately been applied to the driving of saw-mills, and they easily cut from 8,000 to 8,000 feet of boards per day. We have not time to go into an extended or detailed account of the useful operation of the machine, but will merely say in brief, that, for labor-saving, economy of operation, efficiency of working and being moved from place to place, the portable engine is a very valuable and useful invention. Possessing the great elements of easily applied power, economy, efficiency and adaptability to work, it will readily receive the favorable suffrages of every practical man. Any one having work to do where horse or manual power is found to be insufficient, or where the expense of erecting a stationary engine is not warranted, should give Mr. Archambault's advertisement a reading.

### FRENCH WEIGHTS AND MEASURES.

We proceed to give the exact equivalent of the French weights and measures in our own:

| | | |
|---|---|---|
| 1 mètre | = | 39.371 inches. |
| 1 are | = | 119.6046 square yards. |
| 1 litre | = | 2.1136 wine pints. |
| 1 stère | = | 35.1741 cubic foot. |
| 1 kilogramme | = | 2lb. 3oz. 4½dr. avoirdupois. |

It is needless to say that the fractions being computed decimally, to find the equivalent of any of the subdivisions of the above measures or weights, the reader will only have to carry the dot one figure further to the left for .1, two figures for .01, three for .001, reversing this operation for the multiples.

The tenth part of a *mètre*, or in one word a *décimètre*, is equal to 3.9371 inches; while ten *mètres*, or a *décamètre*, is equal to 393.71 inches; and so likewise with the other measures.

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### BLASTING ROCKS.

A highly interesting paper, "On the Quarrying and Blasting of Rocks," was read by Mr. WILLIAM SIM, of the Granite Quarries near Inverary, who observed that the quarrying and blasting of rocks may be considered as one of the rudimentary arts, connected equally with the profession of the engineer, the architect, and the practical builder. Up to a very recent period, the mechanical modes of displacing large masses of rock had remained nearly the same as when the practice of applying gunpowder for the purpose had been first introduced. The ordinary method adopted of blasting rocks involved three separate and distinct operations—namely, the boring of the holes, charging them with gunpowder, and firing them—processes all of which were in general tedious, uncertain, and unsafe. It was, therefore, natural to expect that, in an age of progressive science, some efforts would be made at improvement, and the first attempt was some years ago, at the Chalk Cliffs near Dover, on the line of the South-Eastern Railway Company. A blasting operation was there effected on a scale of surpassing magnitude, by an explosion of 18,500 lbs., nearly 8¼ tons, of gunpowder, fired simultaneously in three mines by electrical communication, and with complete success. It did not appear that any further effort was made in this direction, until the contractors for the Government breakwater at Holyhead commenced their extensive works in that harbor. It being then found that the ordinary mode of blasting could do little towards supplying the enormous quantity of stone, 4000 or 5000 tons per day, required for the breakwater, they had recourse to blasting on the Dover cliff principle, and with the most successful results. The contractors for those great works are now expending not less than 300 tons of gunpowder annually in blasting on an enlarged system.

The first introduction of the improved plan into Scotland occurred in Mr. SIM'S own practice, at the granite quarries on the estates of his Grace the Duke of ARGYLL, at a small village called Furnace, situated on the banks of Loch Fyne, about eight miles south-west of Inverary. These quarries were being extensively worked, chiefly to supply the City of Glasgow with causeway paving stones, the material being of a hard description, as could be seen by the specimens exhibited to the meeting. In proof of its hardness, it was remarked that a tool which will bore from 12 to 15 in. in ordinary granite without requiring to be sharpened, will in this rock only bore 2¼ inches.

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### PENNSYLVANIA SOAPSTONE.

An American in London, in a communication to the *London Mining Journal*, states that the same causes which contributed to the formation of soapstone in Cornwall, seem to have produced the same result in Pennsylvania. He says:—

"On the banks of the river Schuylkill, ten miles above Philadelphia, the gneiss which, alternating now and then with mica, schist, and porphyry, has prevailed for the whole of that distance, is succeeded by an extensive tract of serpentine. The gneiss is much invaded by veins of trap and granite; and, at the junction, a great dyke of granite shows itself crossing the river. It is at this precise spot that the soapstone in massive, irregular deposits, is seen. Nodules of serpentine are included in the deposit. The citizens of Philadelphia have good reason to remember this soapstone, since for a long time the doorsteps of their houses were invariably made from it. The rock wore away more speedily than the serpentine, which protruded in hard, indestructible rough balls, not very genial to the soles of one's shoes. It is now wholly replaced by marble for doorsteps; but, for lining furnaces, where great heat is to be encountered, the soapstone is still extensively quarried and applied. It occurs on both sides of the river Schuylkill, here 300 feet wide, and on the east side is not less than 40 feet thick.

A single fact attending the occurrence of this deposit may, also, be here mentioned. The soapstone is interspersed with little nodules of iron pyrites. The portion of the rock in which this is most abundant wears off into a sugary substance. On being analyzed by a young Philadelphian amateur chemist, Theo. Rand, this substance was found to contain 8 per cent. of epsom salts—(sulphate of magnesia").

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COBALT AND NICKEL.

M. Deville, in a paper before the French Academy, suggests "that other more common metals than aluminum are perhaps less known than may be thought, and he expressed a hope that when he shall have completed a memoir on the pure metals, produced and melted by certain, yet secret processes, which he has long been preparing, he shall exhibit some unexpected results. Thus he instanced cobalt and nickel, which possess useful physical properties, such as malleability, ductility, &c., developed to a most extraordinary degree; further, they enjoy a tenacity far exceeding that of iron, which hitherto has passed as the most tenacious metal; for, according to the experiments made by M. Wertheim on these metals, the weights which determine the rupture of wires of iron, cobalt, and nickel of the same dimensions are, 60 for iron, 115 for cobalt, and 90 for nickel, which shows the tenacity of cobalt double that of iron; besides, nickel and cobalt are worked at the forge with the same facility as iron, are oxidized less easily than iron, and are susceptible of being employed in the same manner as iron."—*Annual of Scientific Discovery*, 1856.

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## NEW PUBLICATIONS.

*Pocket Book for Railroad and Civil Engineers.*—This manual contains new, exact and concise methods for laying out railroad curves, switches, frog angles, and crossings; the staking out of work, levelling; the calculation of cuttings and embankments, earthworks, &c. Also plans and rules, embracing the laying out of railroad curves by ordinate tables of whole numbers—how to drive side stakes exactly, without trial and error; also a rule to find exactly the height of equivalent level cross sectional areas, when the cross sections of cuttings and embankments are irregular—also a general earthwork table without supposing the slide slopes and embankments to meet under the centre of the road; also calculations of cuttings and embankments; together with much that is new and valuable to engineers. It is by Oliver Byrne, an eminent engineer, and for sale by C. Shepard & Co.

THE

# MINING MAGAZINE:

DEVOTED TO

## Mines, Mining Operations, Metallurgy, &c., &c.

VOL. VI.—MAY & JUNE, 1856.—Nos. V. & VI.

### ART I.—PROCESSES FOR THE DISTILLATION AND PURIFICATION OF THE PRODUCTS OF COAL. By MANSFIELD. No. 2.

[Continued from page 300, Vol. VI.]

As obtained by rectification from the still, this spirituous substance will, however, usually be mixed with a greater or less quantity of alliole and of the next spirituous substance, namely, toluole, which generally exists in the naphtha in large quantities, and which boils, when pure, at about 110 degs. A considerable quantity of this spirituous substance may be obtained by setting aside separately the last portions which pass over through the head in which the water is allowed to boil. After the temperature in the retort has reached 100 degs., or if more than one partial condenser is used by reserving the fluid which will be found in the intermediate receivers or distilling vessels, in which the temperature being between 90 degs. and 110 degs. the benzole has been distilled off, while the cumole together with part of the toluole has been kept back in the retort by the first head, and a further portion may be obtained by setting aside the first portion of distillate, which comes over on distilling through a common retort neck with or without water or steam, the residue kept back in the retort by the head on the distillation of the benzole, and it is best to set aside for toluole what comes over before the boiling point reaches 130 degs. This spirituous substance is not destroyed by agitation with concentrated sulphuric acid, and by concentrated nitric acid it is convertible into an acid somewhat similar to oil of bitter almonds. A current of air passed through it burns with a pale blue flame, and in an open vessel it will take fire on the application of a lighted match to its surface. It is of about the same volatility as good rectified naphtha, and is applicable to many purposes in which a volatile solvent is required. The residue of the crude light oil, after the separation of the aforesaid spirituous substances, consists chiefly of two oils: one of which, viz., cumole, boils at 140 degs., being therefore more volatile than oil of turpentine whose boiling point is about 160 degs., and the other, viz., cymole, which boils at

about 170 degs., and is therefore less volatile than oil of turpentine. Cumole is changed by treatment with concentrated sulphuric acid, so that if a quantity of it, or of the naphtha or oil of coal tar containing it, be agitated with a quantity of concentrated sulphuric acid, a preparation of cumole equal to about the bulk of the sulphuric acid employed, will be concentrated into a resinous substance, which will become partly dissolved in the acid, and by concentrated nitric acid it is convertible into an aromatic oil somewhat resembling oil of cinnamon in taste and smell, or into an acid resembling benzoic acid, according to the strength of the acid, and to the duration and temperature of the treatment with such acid. And this oil, when the spirituous substances having lower boiling points have been sufficiently separated from it by distillation, will not yield to air passed in contact with it, in a "test bottle," vapor sufficient to afford a flame; neither will it take fire on the surface when of the ordinary temperature of the air, upon a lighted match being plunged into it in an open vessel. If, however, all the spirituous substances be not separated from it, but only the alliole, and a large proportion of benzole, it will, with the toluole which is mixed with it, have most of the physical characters and properties of the common naphtha of commerce, it should be received, if required separately, when the boiling temperature in the retort is between about 150 degs. and 170 degs., on the first distillation of the light oil, and on subsequent rectification, at a temperature nearer to 140 degs.; it will, however, require many rectifications, before it has been so far freed from the spirituous substances as to yield an oil boiling at 140 degs., and not having the property, like common naphtha, of catching fire on the surface on the approach of a lighted match.

The oil next following in the scale of boiling points, viz., cymole, which boils at about 170°, also has not the property like common naphtha of catching fire at the surface at the ordinary temperature of the atmosphere, but will extinguish a match or lighted taper if plunged into it, and this oil, which is obtained chiefly from such portions of the oil of tar as boil at temperatures higher than the previous substance, is more easily obtained free from spirituous substances; and when I require to obtain a volatile oil lighter than water, and characterized by not inflaming on the application of a lighted match to its surface, I usually manufacture an oil which is a mixture of cumole with cymole, and to this mixture, or to the oil having such properties and prepared from coal-tar, or the oil of coal-tar, I apply the name of Camphole.

I now proceed to describe the method which I find most convenient for obtaining such a product.

In distilling the naphtha from which all the benzole has been separated by the processes above described, or in distilling the

naphtha or light oil from which benzole has not been separated, for the purpose of obtaining camphole, the ordinary methods of applying fire, or passing steam through the naphtha are applicable, unless it is intended to regulate the distillation by the boiling point of the fluids in the retort, and in that case the distillation by steam is not applicable; and if the thermometer be not used for this purpose, the aforesaid property of non-inflammability at the surface affords a convenient test for the time when the receiver should be changed for the separation of camphole. And I apply this test by occasionally collecting a small quantity of the distillate as it runs from the condensing apparatus, from which it should run perfectly cold, in an open cup or saucer, and plunging into it a lighted match or taper. When the fluid no longer catches fire on the surface, but extinguishes the light, I change the receiver and collect now for camphole. I now continue to receive this oil until either the temperature of the retort reaches 200°, or 190°, or till the specific gravity of the oil reaches nearly that of water, or till common soft solder placed on the retort melts. Either of these indications shows that an oil having a higher boiling point and greater density than the product which I call camphole is coming over. Camphole in the crude state may have a specific gravity varying from .880 to .980, or if the distillation be continued further, to .1000, and this increase of density is owing to the mixture of denser oils, especially of naphthaline. When pure (that is, when consisting only of hydrocarbons lighter than water) its specific gravity is not higher than .87, though to reduce it to this purity it requires many rectifications. It is partly destroyed by strong sulphuric acid, the cumole which it contains being converted by that acid into a viscid resinous substance; it is violently acted on by strong nitric acid, which converts it into heavy oil, or into acid substances, in a manner analogous to the action of that acid on the oil boiling at about 140°. This oil is generally accompanied by creosote, whose boiling point is about 200°. I rectify this oil by repeated distillation, either setting aside the first portions which come over on re-distillation, and which will be more volatile than the rest of the oil, and will take fire on the surface, or allowing these first portions to be mixed with the subsequent portions; and on each such distillation I prefer to cease receiving when the temperature in the retort reaches 190°, or 200°; or, in place of the above, I rectify the oil by one operation in a manner analogous to the method recommended for distilling the more volatile substances from naphtha, except that it is necessary in this case to surround the still head with a fluid, having a higher boiling point than that of water; and for this purpose I prefer oil either volatile or fixed; if fixed oil be used, I maintain the temperature of the oil surrounding the head at a temperature which shall allow all the vapors of the camphole to pass over, but as

little as possible of any substance having a higher boiling point; and for this purpose I prefer to keep the temperature of the head at or below 170°, by an occasional supply of cold oil, replacing oil which has been heated by the vapor which it condenses. And if volatile oils be used for the partial condensation, I prefer to take some of the oil of coal-tar which it has been distilled from, till the temperature of the boiling fluid has reached 170°, so that one heat being applied again to the oil, it shall commence to boil at 170°; and I place this oil in the outer vessel which surrounds the condensing chamber in the head of the retort, which outer vessel is not in this case open above, but is fitted with an ascending tube or neck, by which its own vapors are conducted up to a similar head immediately above, which second head is surrounded with water kept as cold as possible, so that all vapor that is evolved from the oil of the lower condenser is condensed and returned to the lower condenser, so that the oil in the lower or proper condenser will remain constantly at 170°, or at any temperature at which its previous ebullition may have been arrested. In the rectification of the spirituous substance the residue will sometimes contain a quantity of camphole, which may be separated, if required, in the same manner. Further, the product so obtained as camphole, by the method above described, may frequently be mixed with a certain quantity of the volatile spirituous part of the naphtha, or of common coal naphtha, without becoming inflammable at the surface; and it is convenient sometimes to make such mixture, as the mobility and lightness of the oil are thereby increased; but if too much of the volatile oil be added, the mixture will become too inflammable. Thus far of the crude oil of coal tar which is lighter than water; I further apply my improvement to the treatment of the heavy oil of tar, commonly called "dead oil."

I submit this oil to distillation, preferring, however, to separate it as it is distilled from the tar, into two portions: a first and second—each of which should be about equal to the half of the quantity of dead oil, which the tar should yield—the object of this being to facilitate the separation from the heavy oil of a considerable quantity of the light oil last described, viz., camphole, which will remain in the heavy oil, and almost entirely in the first half, and which is more easily separated from the first half than from the whole of the dead oil together. The treatment is the same, however, whether the heavy oil be treated altogether, or whether the first half be treated alone, for the separation of this light oil. I do not treat the second half of the heavy oil alone for this purpose. I either submit this oil to rectification, by means of steam passed through it in the manner ordinarily practised in the rectification of the light oil, or I distil it by application of heat to the retort containing the oil, either with or without the mixture of water with the oil. I am aware that the rectification

of the dead oil has been practised before, for the purpose of obtaining a farther quantity of fine naphtha from the dead oil; but I must remark that I do not practise this for the purpose of obtaining naphtha from the oil, but to obtain a quantity of an oil which differs in its properties from naphtha, in not being inflammable at its surface, when the oil is of the ordinary temperature of the air. If steam be used, the greater part of the light oil will be carried over with the vapor of the water, and will float on the water in the condenser, and I prefer to stop this process when the specific gravity of the oil so carried over reaches 940°; or I submit the oil to distillation in the ordinary manner, and cease receiving as camphole when the specific gravity has risen to nearly that of water, or when the temperature reaches 200°, or 210°, or when solder will melt on the retort, as described when treating of the distillation of the lost portion of light oil; or I adopt a head to the retort, surrounded with condensing fluid, as described for the lost light oil, whose limiting temperature I prefer to fix at 180°, or 190°, since the boiling point of the same oil will be raised considerably in this dead oil, by the greater quantity of oils having higher boiling points, which are present with it; and I continue distillation so long as any vapor passes uncondensed through this head, or partial condenser; I mix this distillate now obtained by any of these methods with the lost distillate, obtained from the light oil, as above described, being chiefly the same oil, and characterized by being slightly lighter than water, and so inflammable that it will not take fire on the surface, at ordinary temperatures, on the application of a match. Having separated from the dead oil, or from the first half of it, as much of this oil, which I call camphole, as can be obtained by these methods, I submit the residue to distillation, in a still suited to the distillation of a fluid having a very high boiling point, and therefore requiring a high temperature, to be maintained in the retort during distillation; or if the first half of the dead oil has been treated alone, for the separation of the camphole, I mix the residue of it with the second half of the dead oil, or distil it alone; or I treat the residue at once in the manner hereafter described for the purification of the dead oil without previous rectification, but I prefer to distil it once, or oftener, before so treating it, as by this means certain substances are separated from it, which increase its bulk unnecessarily, and which are not required to be purified. And if so much naphthaline be present in the tar as to cause any portion of the first part of the heavy oil to solidify on cooling, when kept separate, I reject the first portions of the oil which distil over, so long as it solidifies when received in a thin film on a cold surface, and I continue to receive the oil either until the distillate, when received upon a cold surface, again commences to solidify, or till it begins to show a decided yellow color, or till the temperature in the retort, as indicated with a

thermometer connected therewith, in either of the modes before described, is 300°, either of which indications shows that the best part of the fluid oil has come over, and that the residue contains too much para-naphthaline, which is an oil solid at ordinary temperatures, boiling at a temperature above 300°, and which diminishes the fluidity of the oil when mixed with it, and on each successive distillation the same precautions ought to be attended to. This oil, when pure, has specific gravity .900, but from the difficulty of ridding it entirely of naphthaline and para-naphthaline, it is, even when rectified, generally rather heavier than water. It boils, when pure, at about 240°. It is not easily destroyed by sulphuric acid; so that oil of vitriol may be used in purifying it. I call this oil, when rectified and purified, Mortuole.

I proceed now to that part of my improvement whereby I manufacture a fragrant oil or oils from some of the spirituous substances and oils distilled from coal-tar. I will first state the method of treatment which I find the most convenient in practice. I use a vessel capacious enough to hold about three times the quantity of oil which is intended to be treated, and with a long narrow neck to check any expulsion of vapor or liquid; which vessel may be of any convenient material that will not be injured by strong nitric-acid, such as glass, which should not be thick, lest it be cracked by the heat which may be evolved during the process, and glass offers the advantage of enabling the process in the vessel to be observed. I place in the vessel a quantity equal in measure to rather more than the quantity of oil intended to be treated, of the strongest fuming nitric-acid that can be obtained, of specific gravity at least 1.50; and I prefer to use the pure acid, free from chlorine. I place the vessel in another open vessel, which is filled with cold water, so as to surround the first vessel and keep it cool; I then pour into the acid as much of one of the light oils, or spirituous substances, hereafter to be particularized, as the acid will dissolve. The point of saturation is ascertained by observing when the liquid separates into two layers; I then remove the vessel from the cold water, and warm it cautiously over a gentle heat till the two layers again mix into one clear solution. I then add a further quantity of oil until the solution begins to appear turbid; I then add a few drops more of the acid till the solution is again clear and uniform, and warm the mixture slightly for a minute or two, not however allowing it to boil, I then pour the whole of the mixture into five or six times its bulk of cold water; a heavy yellow or red oil will fall to the bottom of the water, and should be about equal in bulk or rather more than the light oil originally employed. I agitate this heavy oil with successive large quantities of clean water; I allow the oil to settle to the bottom and draw off the water, after each washing, till fresh water after being thoroughly agitated with the oil has no longer acid properties, or I wash it with a smaller quan-

tity of a clean filtered solution of carbonate of soda or of lime to remove the acid, and then wash the oil, after subsidence and separation, with a small quantity of water to remove the lime or soda salt. A similar heavy oil may be obtained from the rectified light oil of coal tar by the action of nitric acid in other ways, as by using an acid of specific gravity a little lighter than 1.50, which will not dissolve the oil in so large a quantity as a stronger acid, and that not without the aid of heat; and if such acid be used it will be unnecessary to immerse the vessel in cold water, as above described, or by agitating the oil with twice its bulk of a mixture of the ordinary strong nitric acid of commerce with an equal measure of oil of vitriol; but by this method the oil will not be thoroughly converted into the required product, or by heating the oil with a mixture of sulphuric acid and nitrate of potash or soda; but I prefer to use the method above described, as being simpler, and yielding a purer product. And now I come to speak of that part of the oil of coal-tar, which I use for this treatment. The ordinary rectified coal naphtha of commerce, or the oil which I have described as camphole, may be converted into a heavy oil by nitric acid, and if the naphtha or camphole has been previously well purified from the acid and basic oils of coal-tar, the heavy oil so obtained will have more or less of an aromatic or fragrant smell. But I prefer to use the volatile spirituous substance, which I call benzole, since the oil produced from that substance has the most pleasant odor, and for this purpose the benzole should have been previously treated with concentrated sulphuric acid, in the manner which I shall describe, to remove the alliole, pyrrol, and piccoline; but it is not necessary to rectify the benzole thoroughly from the toluole, since the oil produced from the toluole by this treatment is very similar in smell to that produced from benzole. But I prefer to use a spirituous substance which has distilled over while the temperature in the retort, or last rectifying vessel, was between 80° and 100°, in which case the oil will be of a light yellow, or orange color, and will have an odor similar to that of oil of bitter almonds, and is useful as a perfume, especially applicable to soap, or for conferring a pleasant flavor, when used in small quantities, upon articles of confectionery. When undiluted, it is sweet like sugar. If cumole, or a less volatile naphtha be used, the color of the heavy oil produced will be usually red, or dark orange color. The odor of the product will be more like that of cinnamon, and certain aromatic acids somewhat similar to benzoic acid will be produced at the same time, as is also the case with cymole. Care should be taken, especially if the less volatile part of the light oil be used, not to allow the action of the acid to take place suddenly, since the acid acts with violence on the cymole, and may expel the contents of the vessel against the person of the operator. It may be convenient in this case to add the acid

slowly to the oil, instead of pouring the oil into the acid; and it is evident that the same method may be applied to the benzole. The fragrant oil so obtained may be rectified by distillation, if required, either by passing steam though it, or by heat applied to the exterior of the retort containing the oil; but since the oil boils at a high temperature, viz., at about 210° or 220°, and is liable to decomposition if exposed to a higher temperature, it should not be distilled over a naked fire, and it is better to distil it by immersing the retort in a bath of sand or oil, the temperature of which is not allowed to rise above 220°. I call the heavy fragrant oil thus produced from the light oil of coal-tar, nitro-benzole.

What I claim in respect to this first part of my invention is, the manufacture from bituminous matters, by acting upon them at suitable temperatures, of spirituous substances, which are so volatile that a current of atmospheric air, at ordinary temperatures, passed through them may, when ignited, continue to burn with a luminous flame till all, or nearly all such substances are consumed.

I also claim the manufacture from oil, or tarry matters, distilled from coal, by acting on them, or on matters produced therefrom, at different temperatures, of the products herein described, which I have called alliole, benzole, toluole, camphole, mortuole, and nitro-benzole. And here, by alliole, I mean a spirituous substance, which consists chiefly of a hydro-carbonaceous matter, more volatile than benzole; by benzole I mean a spirituous substance whose boiling temperature is chiefly between 80° and 100°, and is such that if cooled to 20° below 0°, it will become in part solid; by toluole I mean so much of the light oil of coal-tar as may remain after the separation of the alliole, benzole and camphole; by camphole I mean an oil lighter than water, which, when of the ordinary temperature of the air, will not take fire on the surface on the approach of a lighted match, and whose boiling temperature lies chiefly between 140° and 180°; by mortuole I mean an oil whose boiling temperature lies chiefly between 200° and 260°, obtained by the methods above described; by nitro-benzole I mean a fragrant oil prepared from the oil of coal-tar by the action of strong nitric-acid.

And now having described the spirituous substances and oils which I manufacture from coal-tar, or from the oils or naphtha distilled from coal-tar, and the methods by which I manufacture them, I will proceed to the second part of my invention, viz., to that which relates to the purification of volatile bituminous and empyreumatic oils, which are found in nature, or produced by the destructive distillation of organic substances, or of mineral substances, containing or consisting of matters of organic (that is, of vegetable or animal) origin; which invention is especially applicable to the spirituous substances and oils which are manufac-

tured according to the first part of my invention, and is partly applicable to the purification of bituminous and empyreumatic oils in general.

I will proceed to describe this part of my invention as specially applied to the spirituous substances and oils particularly described in the first part of my invention, and as I proceed, will show in what manner it is partly applicable to empyreumatic oils in general. As applied to the purification of the aforesaid particular spirituous substances, it depends partly upon the properties and partly upon the nature of the foreign substances which accompany them, and whose presence in the different parts of the distillate depend upon the different volatilities of these foreign substances approaching more or less closely to those of the oils and spirituous substances which I desire to purify.

And for the more perfect understanding of this part of my invention, I will state what these impurities are, of which I propose to free the hydro-carbons. It is well known that ammonia, in large quantities, is present in the crude tar-oil, besides which there are several oily alkaloids, known to chemists as aniline, piccoline, pyrrol, &c., which have different boiling points, and some one or more of these are found in all the crude oil of tar, at whatever temperature it may have been distilled, as some are very volatile and some are less so. All these bodies are removable from the neutral oils by acids, which for this purpose need not be highly concentrated.

There are certain acid oils, such as creosote, carbolic, and rosalic acid, which are found principally in the less volatile portions of the oil. These acids are removable from the oil by treating it with caustic alkalies. Farther, there are some substances in the crude oil which gradually absorb oxygen from the air, and become brown, thus giving the well known property of becoming dark-colored by being kept. There is very little of this substance with the most volatile spirituous substances, and the largest portion of it is found in the oil, which boils between 140° and 200°. These substances are removed by being at once converted by treatment with strong acids or caustic alkalies, or other oxidizing agents, into their brown state, in which they are no longer volatile, and are therefore left behind on distilling the oil.

(To be Continued.)

ART. II.—SECOND ANNUAL REPORT OF THE GEOLOGICAL SURVEY OF THE STATE OF NEW JERSEY, FOR THE YEAR 1855. (TRENTON, 1856.)

IN our April number we noticed the Report of the Survey of the State of Missouri. We have now before us the *Report of the Geological Survey of New Jersey*, 1856. State Surveys have developed another expression of the American mind, and have become marked features of our age. Many of our States have manifested a most praiseworthy interest in the promotion of science, and in furnishing or directing the appliances of experimental research in their natural resources, and have given to the world their results in bibliographical habiliments, indicating some taste and some knowledge of the arts of typography and binding.* The publication by the government of any State of its geology, geodesy, or hydrography, is an implied, if not direct assurance, that the Report is entitled to consideration, is truthful, and contains matters identified with the economics or physics of the State. Emanating from such a power, addressed to another or higher power—the people—it involves a *dignity* and *importance* of no ordinary character, for it has the imprimatur of the broad seal of a sovereign State, and when once issued, is the common property not only of the people of the particular State, but of other States and communities connected with her in the economies of life. There is in such an intercommunication of government and people an essential *propriety and dignity* which should be visible in every medium of this interchange, whether it be a governor's message or a geological report. There is also another thought involved in this consideration of "*propriety and dignity.*" These State surveys involve the observation and devotion of the best minds of the State; years of study and toil, of analysis and induction, are requisite to *furnish* a mind suitable for such works; the most profound scientific attainments—the nicest critical acumen, as well as practical philosophy, are the conditions of membership in the scientific corps on a State survey. Such learning and acquirements naturally endow their possessors with the cognate qualities of refinement, taste and sensibility, and such, we believe to have been, very justly, the attributes of the gentlemen who made up the scientfic corps of the New Jersey survey,—gentlemen of the highest scientific attainments, and sensitively alive not only to their professional reputation, but to the form in which that reputation is made known to the State and the country.

Now let us apply these brief thoughts to the sovereign State of New Jersey and her Geological Report. If the dignity of a State and its relative position in the confederacy may be mea-

* We propose in some future number to give a history of the surveys of the different States.

sured by the typographical dress of its Geological Reports, instead of its resources, then may New Jersey be placed in the category of a *very small State, most profoundly impressed with the value of the smallest and most rigid economy.* A poor paper, on second-hand type, blurred and worn out, contemptibly narrow margins (New Jersey must be a great *economist* of paper), all encased (not bound) in a *half-penny, pea-green pamphlet cover, without title;* all presented to the world with most assured self-complacency—if all these indicate New Jersey's appreciation of her scientific corps, or her *varied and valuable resources*, then we say she is a fit subject for the most profound commiseration, and may claim a full exemplification of the adage, "*magnas inter opes, inops.*" In using the term New Jersey, we mean the government, or power, or committee (whatever be the name), which had the control and direction of the publication of the Geological Survey. As we know not the *individualisms* who composed this publication committee (and we are most happy we do not), we disclaim all personalities, and remember only the broad seal which endorses the Report.

It would seem as if some reflex influence of the great tidal wave of scientific exploration which is rolling over our land had touched the shores of New Jersey, and that her "*publishing power*" had yielded some trifling deference to its behests, had educed some of her native mental treasures and endowments in the shape of a most superior scientific corps, and then, as if ashamed of the spasmodic effort, and afraid that *decent binding, white paper, and legible type*, should be considered State extravagance, had in a most violent and cramp-like fit of economy, smothered the whole production under a garb and guise which would dishonor the saffron-colored literature of a fish-market.

Our reprobation of the *dressings* of this Report would not be so emphatic, and the deficiency in "*dignity and propriety*" would not be so reprehensible were it a maiden effort of New Jersey to develop her resources. But twenty years ago, in 1836, she made a similar spasmodic effort, and with the final Report of Mr. Rodgers, in 1840, that effort exhausted all the conditions of her ability as she apparently has in 1856. The Reports of Prof. Henry D. Rodgers, of 1836 and 1840, have some superiority over that of 1856. They are in *pamphlet* form, it is true, and have *sky-blue, half-penny paper covers, instead of pea-green;* probably in deference to the ethereal spirit of the popular literature of that age, or because the legislative or publishing committee of 1856 were of the "*true Jersey blue*" stamp.

New Jersey may not be aware (so *we* should think), that the Geological State Reports of the several States of the United States are eagerly sought after by European savans, and are bought up at large prices when not procurable by international exchanges. To secure any work or place in the library of a scholar or insti-

tution, it is essential that it should be bound sufficiently strong at least to secure shelf handling, and when unbound or in pamphlet form, either finds its place among the unfinished things of earth or is consigned to the scrap heap. A scientific work of record and reference in pamphlet form, unbound, is only compatible with poverty or parsimony.

After a careful denudation of *our* pea-green integuments, and with the aid of a clear solar light we have spelled our way through the blurred pages of the Report—although we may be, perchance, compelled, as a natural sequence, to seek eleemosynary aid from some New Jersey Eye Infirmary, of which (judging from the illegibility of her public documents,) she must have quite a number on hand.

So much for the externals of the Report, and we turn with sincere pleasure to its internal developments. To this contrast we are indebted for much that is pleasurable in our emotions, and the power of contrast is in this Report most fully exemplified.

Whatever New Jersey may think of her Legislative or "publishing power," she may well be proud of her scientific corps.—We admire the attainments of these savans as well as their practical wisdom. The instructions of Dr. Kitchell to the assistants in the topographical department are worthy of imitation, and if carried out in other State surveys would be of incalculable value to our whole country. Indeed, the whole plan of distribution of forces and acquirements in the Geological, Palaeontological, and Topographical Departments are eminently calculated to eliminate all that was valuable and worthy of record. The New Jersey corps has covered points omitted in the New York and other surveys, and the urgency for a topographical and trigonometrical survey of New York is now earnestly pressed by her citizens, and its present demand commends the wisdom of the New Jersey survey, in carrying on the Geology, Geodesy, and Topography *pari passu.*

New Jersey appears to have been made up in two geologic ages. These periods are developed in the mineral strata, physical geography and soils of two very marked and distinct portions of the State. If a line is drawn from the Delaware near Trenton, as the initial point, and running straight and terminating at the embouchure of the Raritan, we shall have the line of demarcation of the two ages. The portion to the Northward of this line belongs to the Hypogene or Metamorphic series of New York nomenclature, and, excepting a single stratum, its rocks enclose very few organic remains and create some difficulty in determining the relation of these rocks to the North American pliocene or part pliocene formations,—the series however being lower than those containing the anthracites. The mountain ranges which occupy nearly the whole of this North-Western portion are apparently continuations of the New York system, running in a

N. E. and S. W. direction, and their broken and discontinuous alignments and dislocations, the marked difference in the angle of the talus on the North-Eastern and South-Western terminations indicate not only an elevating power, but its line of force, which is the general axial line of the whole range. The metallic strata indicate also a lateral power, and the determination of these forces is intimately identified with the economics of the State.

The South-Eastern division extending from the above mentioned line of demarcation to the ocean, contains very few consolidated rocks, the deposits being chiefly loose sands, with soft clays, corresponding flat surfaces, and with a mean elevation of 40 to 60 feet above the sea. Its strata belong to the Cainozoic and Cretaceous periods of Rogers, and its fossils are truer indicia of its position in our American series, than the fossils of the North-Western division. The absence of deep valleys and vertical banks, and an extensive, though not deep layer of sand, together with the flat surface, render a full determination of its stratification no easy matter.

The order of superposition appears to be surface soil;—sand and gravel;—blue and lead-colored clay, embedding sand, fossil shells in a state of decomposition, producing calcareous marl,—a plastic micaceous blue clay interstratified with ferruginous sands and containing leaves, lignite, amber and other vegetable products, together with fine sulphate of iron, and sulphate of alumina and sandstone;—a brown coarse ferruginous conglomerate often crowning the tops of elevations;—a yellow ferruginous sand analogous in composition to the sandstone;—and finally, a green or marl stratum, being the lowest bed in the series.

Apparently, at some early period, the whole surface of this flat division was upon a level with the tops of the short conical hills which, appearing at Navesink 200 or 300 feet high, are found in different parts of the tract with their longitudinal axes in the same direction as the marl tract, viz. N. E. and S. W. This former level is assumed from this, among other facts, that these hill tops are generally capped with the brown ferruginous sandstone and conglomerate in solid horizontal stratifications, and that the debris of these hill caps are profusely scattered over the surface of the country; in other words, they are hills of denudation. An interesting fact respecting this division suggests more critical observations, viz. the South-Eastern margin appears to be subsiding or settling about 200 feet in a century.

As the object of this magazine is more prominently directed to the *utilizing* of such reports, than to the more critical analysis of their scientific deductions, interesting to us and creditable to the Surveyors as the latter may be, we present a few thoughts suggested by what may be called the economics of the Report.

The South-Eastern division is covered with large deposits of a green sand, or, as commonly called, *marl*, and is mixed up more or less with sand, clay, carbonate of lime in fine powder, and shells.

Phosphoric acid is a constituent of most of these marls, and its quantitative presence determines their value as fertilizers.

The terminal points of these marl beds on the Raritan and Delaware, which appear to have received most attention, display in the lower part of the formation, white and light colored clays, with intermediate beds of pure white sand, called fire sand, covered by beds of dark-colored clay. In some deposits a most valuable quality of fire brick clay is found, which with proper manipulation may be made equal to Stornbridge. The imperfect manufacture of the brick from these deposits, has impaired the value of the clay, which really is of a superior quality.

At various points large deposits of Kaolin appear. One deposit at Coleman's, on the Raritan, at tide water, is worked extensively, not only for home consumption, but for export. It is used extensively for putting the fine glassy surface on paper hangings, and for lining fire-proof iron safes.

We have seen a very fine brick made from clay from Coleman's property, near South Amboy, which is, we think, far superior to the straw or cream-colored Milwaukee brick, and should think it a most valuable addition to our building materials. It is a singular fact, that brick are brought from Lake Michigan to New York at an expense of $30 to $35 per thousand, when the material for a similar brick, only better, are in our own waters, and may be had at half the price. Some of these clays and marls are excellent alum clays. The black clay which overlies the fire and potter's clay abounds in sulphuret of iron and fossil wood, the latter in such abundance in some places as to be used for fuel.

The value of these marls as fertilizers may be estimated from their constituents, and there is no reason in the world why New Jersey may not become one of the very first of our Agricultural States, when she learns how to appreciate valuable resources.—The potash, in these marls will average five per cent. of the whole weight of marl. A bushel, when dry, weighs 80 pounds, and contains 4 pounds of potash, or nearly equal to as much unleached ashes. Phosphoric acid, sulphuric acid, soluble silica, oxide and protoxide of iron, magnesia, alumina, are among the constituents and give value to these great fertilizers. It is the potash and oxide of iron which render the New Jersey potatoes so excellent.

The Cedar Swamps are singular and interesting features of the Southern division. The wood is the white Cedar *Cupressus thyoides*, and the products of some swamps are valued at $400 to $1000 per acre. The soil is a black peaty earth, of vegetable composition, and the fallen timber becomes buried until the produce from beneath the surface is greater than from above it.—These cedar logs are found at all depths, and are *fished* up from *the mud* by means of an iron rod, and when brought to the sur-

face are found perfectly sound. Shingles from these logs are worth from $13 to $15 per thousand.

As before stated, the North-Western division is azoic—the strata highly metamorphic, dislocated, contorted and traversed by intrusive dikes of granite, sienite, &c. Their constituents interchangeably are quartz, hornblend, feldspar, mica, white limestone, magnetic iron ore, epidote, &c., &c.

The white limestone abounds in rare minerals,—such as red oxide of zinc, now so well known for its paints, franklinite, limonite, specular iron.

This whole division abounds in minerals, a list of which would comprise a large part of our ordinary mineralogical nomenclatures, and many of the highest value in the arts of life.—The pictorial illustrations of some of the mines and mineral properties convey very graphic delineations of their prominent features. Indeed we scarce know of a State in the Union that comprises such varied and valuable resources as New Jersey possesses in the metalliferous belt of her Highland region, and she was not inaptly named "The Iron State."

We have not room for a thorough and critical analysis of this Report; but, in conclusion, we may, with great fairness, commend it for its valuable contribution to our sciences, its practical character, and the perspicacious mode in which it has *utilized* the rich materials of the State and made them comprehensible to her humbler citizens. Were we to cite some passages of bad grammar, involved style, and illogical deductions, we might, after what we have said of the "getting up" of the Report, perhaps be called hypercritical, and we therefore shelve it among our valuables for future study and improvement.

We subjoin a list of the members of the scientific corps, and in view of its *materiel* we anticipate their future eliminations with pleasure.

Wm. Kitchell, State Geologist and Superintendent.
Egbert L. Veile, State Topographical Engineer.
George H. Cook, Assistant Geologist, assisted by
Messrs. Nicholas Wickoff, Alexander M. Kelvey, Abraham Van West, Julius Kock, P. D. Kniskern and Wm. Snowden.
Messrs. R. W. Patterson and W. Wagner, assisted in the exploration of the iron region of Morris County.
Henry Wurtz, State Chemist and Metallurgist, has handsomely contributed to our fund of chemical and mineralogical sciences.
On account of ill health, Prof. James Hall has been substituted for Prof. T. A. Conrad, in the Paleontological department.

ART. III.—THE IRON MANUFACTURE OF GREAT BRITAIN—THEORETICALLY AND PRACTICALLY CONSIDERED. By WM. TRURAN, C. E. No. 5.

[Continued from page 287.—Vol. VI.]

## THEORY OF PRODUCTION.

THE blast furnaces now employed for the reduction of iron ores, vary considerably in dimensions and produce of metal. Under corresponding conditions of ore, fuel, and blast, the produce will be in nearly the same ratio as the cubic capacity of the furnace. With furnaces of similar capacity, and working on similar materials, but blown with different volumes of blast, the produce will vary with the volume of blast. But in the production of gray iron the power of the furnace is limited to a certain quantity weekly. Hence, with similar solid materials, the capacity of the furnace, and volume of blast, principally determines the weekly produce of metal of a given quality. A maximum produce from a furnace is essential to the economical manufacture of iron. As the subject is one of great importance to the smelter, we shall state the produce with different furnaces, blasts, ores, and fuels, and the various proportions which the materials bear to each other, to the resulting metal, and to the capacity of the furnace.

The foundry-iron furnace at the Dowlais works is of 275 cubic yards' capacity, and is blown with a blast of 5390 cubic feet of air per minute. The materials charged at the top consist of calcined argillaceous ore, coal, and limestone. The yield or consumption averages 48 cwts. of calcined ore, 50 cwts. of coal, and 17 cwts. of broken limestone, to 20 cwts. of crude iron obtained. The weekly make of iron is occasionally over 130 tons; but we may assume this as sufficiently high for our calculations. The produce of cinder, weekly, amounts to nearly 250 tons.

The weekly consumption of solid materials at top will be as follows,—calcined ore, 312 tons; coal, 325 tons; limestone, 110 tons, 10 cwts.:—total, 747 tons, 10 cwts. By measurement, these materials in a mass would occupy 1066 cubic yards.

The air delivered by the tuyeres weekly, weighs 1695 tons, and measures 50,550,000 cubic feet, or 1,872, 200 cubic yards.

With these quantities we deduce the following ratios, as being the extreme proportions when the iron is of a gray quality. Nos. 1 and 2, smelted from argillaceous ores with raw coal as fuel.

The weekly consumption of solid materials is at the rate of 54 cwts. per yard capacity.

The weekly produce of liquid matter from the hearth is nearly 28 cwts. per yard capacity of furnace.

The produce of metal from the hearth is at the rate of 9½ cwts. weekly, for each yard capacity of furnace.

Each ton of coal charged into the furnace suffices for the production of 23.4 cwts. of liquid matter on the hearth.

Estimated on the carbon in the coal, the ton of iron is produced with a consumption of 43-5 cwts. of carbon; and the ton of liquid matter, iron and cinder, deposited in the hearth, with a consumption of 17.1 cwts. of carbon.

The solid materials introduced into the furnace weekly, measured in their original form 1166 cubic yards; the liquid matter obtained, measures 171 cubic yards.

The solid materials charged at the top, are in the furnace 40 hours before reduced to the liquid form.

The solid materials descend through the throat at the rate of 28 inches per hour; at the top of the boshes the velocity of descent is reduced to 7 inches per hour, but is accelerated at the hearth to 35 inches.

The consumption of blast per minute is at the rate of 20 cubic feet of air to each yard capacity of furnace.

The ton of crude iron is produced with a consumption of 388,850 cubic feet of air.

The air decomposed in the process of smelting one ton of iron weighs 13 tons.

The weight of the air introduced through the tuyere is to the weight of the solid materials introduced at top, as 16 is to 7.

The materials, solid and gaseous, charged into the furnace, for each ton of iron smelted, weighs 18.8 tons.

The weekly consumption of solid and gaseous materials weighs 2442 tons, of which 380 tons are obtained in a liquid form from the hearth; the remaining 2062 tons escape in the gaseous form at the tunnel head. Hence, for each ton of liquid matter obtained, 129 cwts. of gases are evolved from the furnace.

The atmospheric air introduced weekly, measures 1,872,200 cubic yards; the gases evolved from the tunnel head measure 7,488,000 cubic yards.

The ascending gases traverse the furnace at its largest diameter at the rate of 415 feet per minute, increased at the throat to 1660 feet.

The time which elapses from the admission of the atmospheric air at the tuyere, to its escape at the tunnel head in combination with the gaseous products of combustion, is nearly 7 seconds.

For the production of white iron for the forge, in furnaces of the same capacity as the foregoing, a larger volume of blast is employed along with a different burden of materials. The blast averages 7370 cubic feet per minute. The consumption of materials to a ton of crude iron averages 28 cwts. of calcined argillaceous ore, 10 cwts. of hematite, 10 cwts. of forge and finery cinders, 42 cwts. of coal, and 14 cwts. of limestone. With these materials, the weekly produce amounts to 170 tons of crude iron, and 310 tons of cinder.

The consumption of solid materials is 884 tons, measuring 1103 cubic yards, and of air 2318 tons, measuring 93,988,000

cubic feet. Hence, the total weekly consumption amounts to 3202 tons, which is resolved during the smelting process into 480 tons of liquid, and 2722 tons of gaseous matter.

Under these circumstances, the consumption of solid materials is increased to 64 cwts. per yard capacity, but the volume is not sensibly greater, consequently they are in the furnace nearly the same time as for gray iron.

And the liquid and gaseous products bear to each other nearly the same relation as in the production of gray iron.

But the ton of crude iron is produced with 36.5 cwts. of carbon, and the ton of liquid matter with 13 cwts. of carbon.

In consequence of the larger volume of blast, and comparatively dense manner in which the materials lie in the furnace, the gaseous column escapes with the high velocity of 2900 feet per minute; hence, the time occupied by the ascending gases in traversing the height of the furnace is reduced to 4 seconds.

For the production of a more inferior iron for the forge, the burden is composed of the following materials:—hematite ore, 16 cwts.; refinery cinders, 25 cwts.; coal, 36 cwts.; and limestone, 16 cwts. to the ton of crude iron. Capacity of furnace and volume of blast, the same as in the last instance. A weekly produce of 190 tons has been attained, accompanied with the production of 295 tons of cinder. The weekly consumption of solid materials amounts to 883 tons, measuring 934 yards, of air 2318 tons, —total 3201 tons. This is resolved into 485 tons of liquid, and 2716 of gaseous matter.

In the production of this cinder iron, then, the consumption of solid materials is at the rate of 64 cwts. per yard capacity; but from their greater density, the time which they are in the furnace prior to fusion is increased to 46 hours.

The ton of iron is produced with a consumption of 31.3 cwts. of carbon, and the ton of liquid matter with 12 cwts.

The materials used being of a greater density, the ascending column of gases traverse the heights of the furnace in 3.5 seconds.

The Hirwain foundry-iron furnace measures nearly 200 cubic yards, and is blown with 2541 cubic feet of air per minute. Yield of materials,—calcined ore 46 cwts., coke 34 cwts., limestone, 16 cwts., to a ton of crude iron. Produce, 90 tons of crude iron, and 150 tons of cinder, weekly.

Hence the weight of solid materials introduced weekly is 432 tons, measuring 730 cubic yards; and air 800 tons, measuring 23,783,000 cubic feet.

Consumption of solid materials per yard capacity of furnace, 43 cwts.

Produce of crude iron per yard capacity, 9 cwts.; of liquid matter 24 cwts.

The ton of iron is produced with a consumption of 32 cwts. of carbon, and the ton of liquid matter with 12 cwts.

*The solid materials comprising the descending column are in the furnace nearly 48 hours.*

In consequence of the diminished volume of air, and the porosity of the coke, the ascending gaseous column is 12 seconds in traversing the height of the furnace.

By employing a larger volume of blast, the produce of iron from the Dowlais and Hirwain foundry-iron furnaces may be largely augmented, but with the proportion of carbon given, the resulting iron is of a white quality. With a larger volume of carbon, however, the gray quality may be maintained with the augmented produce. By employing a lesser volume of blast, accompanied by a diminished produce, a reduced volume of carbon suffices for the production of gray iron.

The larger consumption of carbon, to produce gray iron with a volume of blast exceeding 20 feet per minute per yard capacity of furnace, is partly due to the more rapid descent of the materials permitting of a lesser quantity of gaseous carbon combining with the metal. The chief cause, however, we consider to be the accelerated velocity with which the ascending column of gases pass through the furnace. In the Dowlais furnace the ascent occupies 7 seconds, in the Hirwain furnace 13 seconds. Hence, in the latter, the vapor of carbon in the ascending column is in contact with the materials nearly twice the length of time. It is principally to this circumstance that we ascribe the lower yield of carbon to the ton of liquid matter produced from the Hirwain furnace. Probably the degree of carbonization is dependent more on the velocity of ascent of the gaseous carbon than on the quantity of solid carbon charged at top. On no other supposition can we account for the superior reducing power of a given weight of carbon in the Hirwain furnace.

The consumption of carbon to produce one ton of crude iron, and to produce one ton of liquid matter is almost identical at the Dowlais cinder-iron furnace, and the Hirwain foundry-iron furnace; but in the former, notwithstanding the materials are in the furnace 3 hours longer, the quality of the iron is an inferior white, while that of the latter was fair ordinary gray. But in the velocities with which the gases pass through there is a wide difference. The heated gases escape from the Dowlais furnace with a velocity of 2900 feet per minute, and traverse the furnace in 3.5 seconds; in the Hirwain furnace the escape is at the reduced rate of 788 feet per minute, and the time of traversing the height of the furnace increased to 12 seconds.

If the degree of carbonization were dependent on the quantity of vapor of carbon brought in contact with the ore, the Hirwain furnace possesses no superiority over the Dowlais, the like quantity of gaseous carbon being evolved for each ton of crude iron. But if time is an element, which in connection with the gaseous column affects the degree of carbonization, the immense difference in quality is immediately explained. When the important part played by the gaseous matter in the reduction of the ore is considered, the probability that the velocity of ascent has a great

er influence on the quality than the quantity of solid carbon charged at top, is greatly strengthened. In the Dowlais furnaces the vapor of carbon ascends at the rate of nearly 50 feet per second; it is while in this rapid motion that the gaseous carbon has to effect the deoxidation of the ore, and carbonization of the metal. The perfect combination of the oxygen of the ore with the gaseous carbon being the work of time, the great velocity of the gases in the Dowlais furnace cannot be so favorable to the combination as the reduced velocity of the Hirwain furnace; hence, the deterioration in quality.

It is probable, however, that the nature of the ore has an important connection with the degree of carbonization in certain cases, though not in the one described. With the dense hematites, and silicious ores, the gases volatile in the upper regions are of inconsiderable amount, and the original dense structure of the ore is nearly unchanged. The deoxidizing influence of the gaseous carbon consequently is limited to the surface of the pieces; and of the oxygen in the original volume of ore, a large portion is liberated at the zone of fusion. Hence, an inferior white iron, containing a minimum dose of carbon is produced.

The argillaceous and carbonaceous ores—the carbonates of the coal formations, are of a totally different structure in the furnace. The operation of calcination expels the carbonic acid, and leaves the roasted ore of a porous structure, permeable to the gaseous carbon, and augmenting the surface of metal exposed to the deoxidizing influence of the ascending column. With the carbonaceous ores the combustion of the carbonaceous matter, coupled with the expulsion of the carbonic acid, results in the ores of this class being highly susceptible of deoxidation. All other conditions being similar, the carbonization of the metal will be in nearly the same ratio as the porosity of the ore.

By employing a larger blast, the produce may be largely increased at the expense of quality. With a suitable blast the weekly produce of inferior white iron may be doubled, and a make of 300 tons be readily attained. With this large produce, however, the manufacture is not so economical as with lesser quantities.

The produce of furnaces smelting carbonaceous ores is not subject to the same limits as to quality, as furnaces on other ores. From the large quantity of carbonaceous matter in combination, the richness of the ore in metallic iron, and its porous structure, a larger quantity of metal of a given quality may be produced from the same capacity of furnace. The volume of blast is much smaller, and the produce of cinder scarcely exceeds in weight that of the crude iron.

The furnaces at the Dundyvan works, Scotland, average 167 cubic yards capacity. Blast 3040 cubic feet per minute. Yield *of materials*—calcined carbonaceous ore 33 cwts., coal 40 cwts.,

and limestone 5 cwts. to the ton of crude iron. On these materials the furnaces average 150 tons of iron, and 140 tons of cinders weekly. The consumption of solid materials is 584 tons, 10 cwts., measuring 785 cubic yards. The blast weighs 950 tons, and measures 28,454,000 cubic feet. Hence, the consumption of materials amounts to 1434 tons, which is resolved into 290 liquid and 1144 tons of gaseous matter. A ton of the former is accompanied with 78 cwts. of the latter, against 129 cwts. with the argillaceous ore.

The weekly consumption of solid materials, is at the rate of 70 cwts. per yard capacity of furnace.

The weekly produce of liquid matter from the hearth is 34 cwts., and the crude iron 18 cwts. per yard capacity of furnace.

Each ton of coal charged into the furnace suffices for the production of 21 cwts. of liquid matter. Estimated in the carbon, the ton of iron is produced with a consumption of 30.4 cwts., and the ton of liquid matter with 15.6 cwts.

The solid materials forming the descending column are in the furnace 33 hours prior to fusion.

The consumption of blast per minute is at the rate of 18 cubic feet per yard capacity of furnace.

The air decomposed in the process of smelting one ton of crude iron weighs 6.3 tons.

The gases escape through the throat with a velocity of 1500 feet per minute.

The gaseous column is 7.5 seconds in ascending from the tuyeres to the throat.

Iron smelted from carbonaceous ores with the fuel and blast described, contains a larger per-centage of carbon than is found in Welsh irons smelted from argillaceous ores, as will be seen by referring to the analysis of crude irons. The principal defect of the Scotch pig iron is seen in this large per-centage of carbon, rendering it excessively fluid, and incapable of being readily converted into malleable iron. On reviewing the quantities of liquid matter obtained from the hearth, for a given weight of carbon consumed, the Scotch furnaces are placed in a most anomalous position. Smelting the most fusible ore extant, 15.6 cwts. of carbon are consumed for each ton of liquid matter produced. At the Hirwain foundry-iron furnace smelting a less fusible ore, the consumption is only 12 cwts. It is this excess of carbon to liquid matter, coupled with the comparatively slow ascent of the gaseous column, and the very fusible character of the ore, which lowers the quality and strength of the crude iron.

For the production of this metal from carbonaceous ores, for conversion into malleable bars of a superior quality, with a minimum waste in the refining and puddling processes, the proportion of carbon to liquid matter must be reduced more than one half, and the velocity of the ascending gaseous column accelerated to twice its present rate of ascent. The resulting metal will then

contain a low per-centage of carbon, and may be readily converted into malleable bars.

### QUALITIES OF FURNACE CINDERS.

The changes of quality presented by the cinder, indicate with considerable precision, the quality of the metal deposited in the hearth. Local circumstances, however, will frequently so modify the liquidity, color, and texture, that the indications presented by the cinders of one furnace are not applicable to the products of other furnaces. Various oxides, other than those of iron, give the cinder color, and impart additional fluidity.

As a general rule, however, a cinder of a stony gray fracture, glazed on the surface, possessed of moderate fluidity, and having a slight tenacity, indicates the production of gray iron. If the color approaches to a white, with a disappearance of the glaze and less fluidity, cooling rapidly in its flow, the lime is in excess; but on the whole this cinder is favorable to a high quality of metal.

The opposite quality of cinder indicating the lowest quality of crude iron is of a dense lustrous black color, highly glazed on the surface when cold; it is deficient in fluidity, and utterly void of tenacity.

A black cinder is invariably accompanied with white iron; a gray cinder may from peculiar circumstances be accompanied with a similar inferior iron, but the black cinder is never accompanied with gray iron.

Between the black and gray cinders there are numerous intervening qualities, possessing more or less color, fluidity, and tenacity, according to the quantity of metal in alloy. The brown varieties frequently possess great tenacity, and, when cold, the slender threads have considerable flexibility. They are usually accompanied with mottled iron.

### QUALITIES OF CRUDE IRON.

The various qualities of crude iron are usually denominated as Nos. 1, 2, 3, 4, according to the color, which in the respective Nos. is dark gray, bright gray, mottled, and white. Although convenient terms for defining the degree of carbonization, they are not available as measures of the intrinsic value of iron thus denominated. The variable qualities of the ore, fuel, and blast employed, will influence the qualities of the resulting crude iron, and render a low denomination of one manufacturer, of greater commercial value, than a higher denomination of other makers.

The characteristics presented by the fluid metal are numerous, but do not indicate precisely the quality. When cold, however, the fracture of the metal (regard being had to the size of the piece examined), will present distinct characteristics for each denomination. In the pig of No. 1, the color is a dull dark gray, with considerable uniformity in the crystalline texture; the surface

of the pig is smooth and convex, from which circumstance it is frequently termed smooth-faced foundry. The No. 2 is of a bright gray color; the crystallization is more distinct, the granules being large, and exhibiting more lustre, but diminishing in brilliancy and size towards the edge; on the surface the metal is rougher than No. 1, and deficient in convexity.

The No. 3, is of a mottled fracture, dark grayish in the middle receding to white on the edges; the crystallization is finer and more uniform in texture; on the surface the convexity is wanting and a considerable roughness exists. The No. 4, is of a white fracture, and uniform crystalline structure, but exceedingly rough on the surface, and possessing a degree of concavity. The surface of the pig is one of the most certain indications of quality; where it is smooth and convex, the iron is of a high local rank, possessing great fluidity, and remaining liquid for a considerable period; but when the surface is rough and concave, the quality is low, deficient in fluidity, and setting immediately on entering the bed. In the lowest qualities of pig iron the roughness of the surface is scarcely inferior to that observed on high blown refiner's metal.

## SECTION VI.—YIELD OF MATERIALS.

### *Iron Ores.*

The quantity of ore or other material consumed in the manufacture of one ton of iron, is known amongst smelters as the "yield" of that material. When the consumption is small for the quantity of metal produced, the yield is considered good; when large the yields are pronounced bad. This term, though strictly speaking incorrect, is applied to nearly all the operations connected with an iron works. In well-regulated establishments the consumption of materials, labor, stores, &c., in every department, for each ton of metal produced is recorded, and on inspection, the yield of each item may be ascertained and comparisons made. It may be necessary, however, for us to remark, that through this work the term is also used in its correct sense—the produce of metal or other substance from a given quantity of material.

The consumption of argillaceous ore, the quality of the resulting metal being dark gray, will be in an inverse ratio nearly to the quantity of metal in the ore. If it yields 29 per cent., the consumption will be 76 cwts. to each ton of crude iron produced —the crude iron containing 95 per cent. of metallic iron. If the yield is 38 per cent., 57 cwts. will be required: at 46 the consumption is reduced to 46 cwts. A few of the argillaceous ores yield 50 per cent.; with such, the consumption averages 42 cwts.

The whole of the metal contained in the ore is never obtained in the crude iron: a portion remains in the cinder, even when the smelting process has been conducted under the most favorable

circumstances. But with a certain class of ores, the crude iron obtained is of equal weight with the metallic iron in the ores; the per-centage of earths alloyed with the metal being equal to the metallic iron combined with the cinder. The quantity of metallic iron lost in this way will vary with the richness of the ore. With the leanest ores the loss will range from 12 to 25 per cent. of the metallic iron in the ore: with richer ores it will range from 5 to 12 per cent.

The gray cinders from furnaces using coke or coal as fuel, contain from 4 to 7 per cent. of iron. Cinders containing a lower per-centage of metal are sometimes produced, but more often the yield exceeds 7 per cent. If, then, the quantity of cinder to iron is large, the loss of metal from this source is very great, and materially depreciates the value of the lean ore. To smelt one ton of crude iron from an ore yielding 29 per cent., 76 cwts. of ore containing 22 cwts. of iron are consumed. The ton of crude iron at 95 per cent. contains 19 cwts. of iron, showing a deficiency of 3 cwts. which is lost in the cinder. With an ore of this per-centage of metal, the quantity of limestone required for fluxing will be large, and the produce of cinder from 60 to 65 cwts. to the ton of crude iron. Estimating that the cinder contains no more than 5 per cent of metal in combination, the deficiency of 3 cwts. of metal is explained. A loss of 3 cwts. is equal to 14 per cent. nearly of the metallic iron in the ore.*

With an ore yielding 50 per cent., the loss will not be so large. The consumption being 42 cwts. to the ton, the metal contained in the ore weighs 21 cwts., or 2 cwts. over the quantity of metallic iron. The 2 cwts. in excess represents the quantity combined with the cinders. From the reduced quantity of earths with the ore, the consumption of limestone is diminished, and the weight of cinders produced will not generally exceed 40 cwts. At a yield of metal similar to the cinder from lean ores, this weight of cinder will contain nearly the quantity of metal deficient in the produce of the ore—2 cwts. This quantity on the metal in the ore, is equal to a loss of 9 per cent. against 14 per cent. with the lean ore.

An ore may be so lean that the metallic iron in the cinders equals that obtained as crude iron. Such ores are not used when others containing a greater per-centage of metal are available; but the disadvantage attending lean ores, from the large proportion of metal lost in the cinder, should induce smelters to con-

* In Messrs. Bunsen and Playfair's memoir on the gases of the Alfreton furnace, the consumption of materials to produce 140 lbs. of crude iron, is stated to have been,—calcined ore, containing 60.242 per cent. of peroxide of iron, 420 lbs.; coal, 390 lbs.; limestone, 170 lbs. Estimating the crude iron to have contained 95 per cent. of metal, it is seen, that, for 95 lbs. of metallic iron obtained from the lower hearth, 122.3 lbs. entered the furnace in the ore. This is equal to a loss of 24 per cent. of the metallic iron of the ore.

sider carefully the extent to which the cost of manufacturing may be increased through inattention to the subject. In smelting with an ore containing 20 per cent., more than 130 cwts. must be used for each ton of metallic iron obtained, showing a loss of metal in the cinder of 25 per cent.; while with one so low as 15 per cent., the consumption will be nearly 10 tons, and the loss 35 per cent.

The consumption of ores of the carbonaceous class to produce a ton of crude iron is probably lower than of any other; and, from the volatile nature of a portion of the matter in alloy, the quantity of cinders produced—under 20 cwts. is the least with which the operations of the furnace can be profitably conducted. The average per-centage of the Scotch carbonaceous ores when calcined is nearly 60; the quantity consumed to the ton of crude iron averages 35 cwts.; the metallic iron in this quantity of ore weighs nearly 20 cwts.; but one cwt. is lost in alloy with the cinder, leaving 19 cwts. of metallic iron in the ton of crude iron. This comparatively small loss—the result of the small quantity of cinder produced—contrasts most favorably with the lean argillaceous ore. Instead of 9 to 35 per cent., as with these, the carbonaceous ore is smelted with a loss of only 5 per cent. of the metallic iron in the ore. This greater produce of metal from a given weight of ore is an important advantage to smelters using carbonaceous ores, and doubtless has contributed not a little to the great extension of late years of the manufacture of crude iron from this class of ores.

The yield from calcareous ores is superior to that from argillaceous, inasmuch that the cinders produced do not bear so high a proportion to the crude iron. Lime being present in the ore in nearly sufficient quantity for fluxing the other earths, the quantity of cinders produced is of limited amount, and their absorption of metal an equal weight of cinder below the average of the argillaceous ores.

The produce of crude iron from silicious ores of a given richness is inferior to that from the other classes. From the infusible character of the alloy a large quantity of limestone is required, forming on fusion with the silicious earths a cold sluggish cinder, from which the metal is imperfectly separated. The quantity of cinders will be large, and their yield of metal from 6 to 8 per cent. In practice, a silicious ore containing 45 per cent. of metallic iron will not produce more than 40 per cent. of crude iron, the cinder absorbing the remainder.

The produce of iron from the best varieties of hematite is lower, in proportion to their richness, than the produce of the argillaceous and carbonaceous ores. Containing generally about 50 per cent. of iron in the raw state, these ores require the addition of considerable quantities of burnt argillaceous shale and limestone for flux, when the resulting crude iron is desired of a good quali-

ty. In consequence of this addition of lime and shale, a comparatively large floor of cinder, 45 to 50 cwts. is produced. These absorb a portion of the metal in the ore, hence, the quantity required for the production of the ton of crude iron is raised from 40 cwts., the theoretical yield, to 45 cwts. This loss is equal to 11 per cent., or two per cent. more than with calcined argillaceous ore of similar richness.

The burnt shale generally used to supply the deficiency of fusible earths in the primary ores contains a small quantity of iron; this combines with that in the ore, and raises the produce of crude iron above what is due to the quantity of metal in the ore.

Hitherto, we have supposed that the furnace is working well on gray iron, and the cinders produced of a gray, stony fracture; but alterations in the quantity, or qualities of any of the materials may result in the production of a white metal and dense black cinder of a glassy exterior and dull lead color within. Whenever from accident or other cause such alterations occur, the produce of crude iron from the ore rapidly diminishes, and the percentage of iron in the cinder is augmented in a similar degree. Under ordinary circumstances a ton of crude iron will require of an ore yielding 50 per cent. 42 cwts., and the gray, stony cinder produced will contain of iron about 5 per cent. of their weight; but when the operations of the furnace are deranged, the consumption of ore will rise so high as 60 cwts., and the cinder will contain a large quantity of iron, amounting in extreme cases to 20 per cent. of its weight; when containing this percentage of iron, the loss will not fall short of 35 per cent. of the metal in the ore.

A furnace may work some months without producing a cinder containing so much as 16 per cent. of metal, but in large establishments it is not difficult to select cinders containing this and even larger amounts of metal. The average yield of the furnace cinders of this country will not fall under 10 per cent. It is supposed by some smelters that the gray cinders contain no metal, but by referring to the analysis of cinders produced under different conditions, it is seen that the gray contain about 7 per cent. of iron.

The larger consumption of ore for a given produce of crude iron which occurs when the furnace is working badly, is shown in the most striking manner by the weekly statement of materials consumed at the Dowlais furnaces. For the week ending April 25th, 1846, the make of the foundry-iron furnace was 115.5 tons, consumption of calcined ore 257 tons, or 45 cwts. per ton of crude iron obtained. This was considered a good yield, but from this point the make declined, the quality deteriorated, the cinders changed to a dull black color, and the yields were in an inverse ratio to the make. In the succeeding month, the make was 86.5 tons, calcined ore consumed 278 tons, or 65 cwts.

per ton of crude iron. Calculating that the percentage of metal in the ore was the same on both occasions, and with the local argillaceous ores the variation from week to week is very trifling, the 278 tons of calcined ore should have produced 123.5 tons of crude iron instead of 86.5. Hence, in the May week the loss of iron from the deranged condition of the furnace amounted to 37 tons, or 30 per cent. of the quantity obtainable under more favorable circumstances. From this ruinous state the furnace recovered in a few weeks, and in July made 130 tons in one week with a consumption of 48 cwts. of ore; but this was evidently forcing it to a production greater than its smelting powers, for in the following week the make fell to 82.7 tons, and the consumption of ore rose to 60 cwts. When the furnace is forced to the production of a quantity of metal greater than its dimensions warrant, irregularities such as these will occur, attended with an increased consumption of ore, fuel, and flux, and the cost of the resulting crude iron, though inferior in quality, will be greatly above that of the best gray iron made in lesser quantities.

The production of crude iron from a mixed burden of ores, for forge purposes, is usually accompanied with a great loss of metallic iron. The quantity of fuel allowed for smelting a given weight of ores, is in nearly every establishment insufficient for the perfect reduction of the iron with existing appliances. From a mistaken idea of economy, the burden of ore and cinders carried by the fuel is fixed so high that the yield and quality of the crude iron is reduced below the proper level. The loss of iron in the cinders is consequently very great. Were smelters to consider for an instant the very different values of pig-iron and coal, it is probable that the quantity thus wasted would be considerably reduced.

The majority of forge-iron furnaces are worked with a loss of full 20 per cent. of the metallic iron in the burden of materials. The cinders produced contain on an average 11 per cent. of iron. It is not unusual to see furnaces burdened so high, that for a period of several months, the cinders produced yield 13 to 16 per cent.

The loss of metal under such circumstances is indeed immense. At a moderate computation, the weight of metallic iron annually thrown away in the cinders—the larger portion from an utter disregard of the simplest principles of the blast furnace—cannot be less than 250,000 tons in the South Wales district alone. In other districts smelting crude iron for fabrication into bars, the waste, in proportion to the quantity smelted, is scarcely inferior to that going on in Wales. Estimated on the entire production of the United Kingdom, the metallic iron lost in the blast furnace cinders must be near 700,000 tons per annum.

This great waste of iron is of comparatively recent date. It is not more than 35 years since the manufacturers commenced

using cinders and the rich ores in the furnace, for the production of an inferior description of crude iron, for refining and conversion into bars. Prior to the year 1820, the forge iron was smelted from the argillaceous ores of the coal formation, without any foreign mixture. The cinders produced were usually gray, light green, or yellow, and contained a minimum per-centage of iron. This was owing in a great measure to the large consumption of coal; 4 to 6 tons being sufficient to smelt carbonated iron under almost any circumstances. Since that period, the burden has been composed in part of cinders, hematite, and silicious ores, at first in small quantities; 3 cwts. of Lancashire ore to the ton of crude iron was considered a high burden; lately, however, the consumption has increased to that extent, that they frequently form the largest portion of the burden of ores. Wherever this is done without a corresponding increase in the fuel, and adaptation of the furnace to the alteration, the resulting cinders are black in color, and contain a large per centage of iron. The smelting power of the fuel having previously been taxed to its utmost, it is unable to carry the furnace through an alteration of burden. That the general quality of forge iron has been lowered in consequence of the increased use of cinders and rich ores, there can be no question; but we may remark, that, for many purposes to which bar iron is now applied, quality is a secondary consideration; and the use of cinders and rich ores in moderation, is attended with numerous advantages to the manufacturers.

(To be continued.)

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## Art. IV.—CHEMICAL ANALYSIS AND COMPARISON OF SERPENTINE MARBLES KNOWN UNDER THE NAME OF VERD-ANTIQUE.—By Charles T. Jackson, M. D.*

Having made the original geological surveys of the great masses of serpentine marbles, which occur in the northern part of the State of Vermont, and described such as would furnish a marble identical with the celebrated verd-antique of Europe, I have since been requested to institute a mineralogical and chemical comparison of the European and Vermont varieties.

The results to which I have arrived possess some scientific as well as practical interest, for they not only show a curious replacement of carbonate of magnesia for carbonate of lime, the magnesite being most abundant in the Vermont marble, while calcite is the predominant spar in the European variety. It has also been ascertained, by experiments made by me some years since, that the Vermont serpentine marble and that mixture

* Boston Society Natural History.

called verd-antique, are uncommonly durable, resisting not only atmospheric agencies, but also the action of acids, and to a remarkable extent that of fire.

Dr. Hayes, in an interesting report on this marble, has confirmed these results, and I am happy in being able also to verify his analysis of some of the magnesite veins, while I also add now some new analyses of other veins in the Vermont marble and of the calcite of the European verd-antique. I offer like analyses of the serpentine of the verd-antique, both of Europe and of Vermont, showing their identity of composition, and also an analysis I made many years since of the softer serpentine of Lynnfield in this State.

Serpentine consists essentially of hydrous silicate of magnesia and silicate of the protoxide of iron, with occasionally a little oxide of chromium—these oxides giving the green color to the serpentine. The presence of water of composition in serpentine materially affects its hardness, the softer varieties containing the largest proportion of water. In some varieties I found as much as 15 per cent., while the lowest was 7 per cent. Both the verd-antique serpentine of Europe and of Roxbury, Vermont, contain between 12 and 13 per cent. of water. That from Proctorsville, Vt., contains but 7 per cent., and of Roxbury, 13, while that from Europe contains 12.5 per cent, and that of Lynnfield 15 per cent.

Verd-antique marble may be defined to be serpentine mixed with or containing numerous veins of magnesian carbonate of lime. The relative proportions of these ingredients may vary considerably on account of the isomorphic, or rather plesiomorphic characters of the two minerals. Carbonate of the protoxide of iron, in like manner being plesiomorphic with both carbonates of lime and of magnesia, replaces either of those minerals in all proportions, without changing the angles of the crystals more than one degree.

It will be observed on examination of the analyses I have made, that in the Vermont serpentine the white spar veins are chiefly composed of magnesite, while there are also veins consisting of magnesian carbonate of lime and of carbonate of iron. The relative proportions of these magnesian and ferruginous carbonates in the Vermont marble are nearly the reverse of those in the European variety, thus beautifully illustrating the law of isomorphous substitution of mineral ingredients.

Owing to the refractory nature of serpentine, and the difficult erosion of the magnesite, the Vermont verd-antique is less liable to decomposition from atmospheric agencies, and also has the property of resisting a high temperature, and even the action of minerals and other acids, far beyond the celebrated verd-antique of Italy. When highly polished, it is a rich and beautiful green marble, veined with white, and sometimes is richly mottled with

magnesite and dolomite spar. Its polished surface is not liable to erosion from atmospheric causes, and will offer no hold for lichens, mosses or other parasitic vegetation, which so frequently mar the beauty of our more open-grained white monumental marbles.

1st. Chemical analysis of the white veins of European verd-antique.

These veins, picked out with great care to avoid any mixture of particles of serpentine, yielded per cent.—

| | |
|---|---|
| Carbonate of lime, | 81.00 |
| Carbonate of magnesia, | 11.70 |
| Carbonate of iron, | 7.30 |
| | 100.00 |

2d. Chemical analysis of the white veins of Roxbury, Vermont, verd-antique marble. These veins were quite common in the slabs examined by me. They were picked out with care, to avoid any admixture of serpentine. On analysis they yielded—

| | |
|---|---|
| Carbonate of magnesia, | 80.00 |
| Carbonate of lime, | 15.00 |
| Carbonate of iron, | 3.50 |
| Silica and loss, | 1.50 |
| | 100.00 |

It will be observed that the carbonate of lime, in the European marble, is represented by carbonate of magnesia in the Vermont variety, and the carbonate of magnesia by carbonate of lime, a reversal of these ingredients.

3d. Chemical analysis of the magnesite veins in Roxbury, Vt., verd-antique.—These veins are probably like those analyzed by Dr. Hayes. They yielded per cent—

| | |
|---|---|
| Magnesia, | 38.88 |
| Carbonic acid, | 37.12 |
| Protoxide of iron, | 9.00 |
| Undecomposed serpentine, | 15.00 |
| | 100.00 |

The protoxide of iron was originally in combination with carbonic acid in the stone, forming carbonate of iron, an isomorph with carbonate of magnesia.

4th. Chemical analysis of the dolomite spar veins in Roxbury, Vt., serpentine.—A cleavage crystal, with angles, of 106.15°, was analyzed and yielded—

| | |
|---|---|
| Carbonic acid, | 46.50 |
| Lime, | 30.52 |
| Magnesia, | 18.47 |
| Protoxide of iron, | 4.25 |
| Silica | 0.05 |
| | 99.79 |

In this mineral the carbonic acid is combined with the lime, magnesia and protoxide of iron.

5th. Chemical analysis of the serpentine of the verd-antique of Europe.—It was picked out clean as possible, reduced to small grains, and washed with very dilute muriatic acid, to cleanse it from adhering carbonate of lime. The attack was made by means of carbonate of soda, in the usual manner of rendering insoluble silicates soluble in acids.

The results obtained were:

| | |
|---|---|
| Silica, | 42.40 |
| Magnesia, | 31.20 |
| Protoxide of iron, | 13.90 |
| Water, | 12.50 |
| | 100.00 |

The Roxbury, Vermont, serpentine, analyzed in the same manner, yielded:

| | |
|---|---|
| Silica, | 42.60 |
| Magnesia, | 35.50 |
| Protoxide of iron and ox. chromium, | 8.35 |
| Carbonate of lime, | 0.60 |
| Water, | 13.00 |
| | 100.00 |

Chemical analysis of serpentine from Lynnfield, Mass.—a light green and rather soft variety.

| | |
|---|---|
| Silica, | 37.5 |
| Magnesia, | 41.0 |
| Protoxide of iron, | 2.5 |
| Carbonate of lime, | 4.0 |
| Water, | 15.00 |
| | 99.0 |

This variety of serpentine is capable of being decomposed by boiling sulphuric acid, and was at one time used in the manufacture of sulphate of magnesia.

It is too soft to be used for ornamental marble, but it withstands heat perfectly after it has been gradually baked so as to expel its water of composition.

It comes nearer to the precious or noble serpentine in composition, than to that of the serpentines of verd-antique marble, which are much harder than noble serpentine.

ART V.—VISIT TO THE LAKE SUPERIOR REGION, IN 1854.*—By Prof. E. RIVOT, of the French School of Mines. No. 4.

[Continued from page 218, Vol. VI.]

## PORTAGE LAKE REGION.

BETWEEN the Albion Mine and the Portage Lake, the grand trap formation does not present exactly the same disposition as in the eastern part of Keweenaw Point. The belt of greenstone ceases to be distinct, and consequently the two metalliferous zones are reunited together and bounded on the south-west by the mountains of crystalline trap and porphyry, and on the north-west by the conglomerates. The beds of amygdaloid and compact trap are still separated by very thin seams of conglomerate or sandstone. They run north-east and south-west, and dip towards the north at an angle of 30° to 35°.

The Portage region presents a still greater distinction in respect to the disposition of the deposits of native copper: throughout all the country where the mountains of greenstone appear, the copper is found in veins cutting at a right angle all the strata; towards Portage Lake the deposits of copper intervene between the beds of trap, and many amygdaloidal layers are penetrated by copper.

South of the Bohemian mountains all the country is composed of sandstone, from the Bay of Bête-Grise even to the west of Ontonagon. In the portion contiguous to Point Keweenaw, limited by Portage Lake, the sandstone runs parallel to the trap, and dips towards the south-east in contact with that rock at an angle of 30° to 50°. Its inclination diminishes towards the south, and on the borders of Keweenaw Bay the beds are horizontal, or even present in many places a trifling inclination to the north.

The appearance of the sandstone is almost the same both in the neigborhood and at a great distance from the trap; it is red or only a little colored, and the beds do not present such a striking difference in their color as on the southern side of Lake Superior at the colored rocks. Besides the trap, the existence of the conglomerates is manifest, but they are far from presenting at the surface the same development as at the north.

Through the vein of the Copper Falls mine the horizontal thickness of the beds and seams of trap, conglomerate and sandstone, are as follows:

| | Metres. |
|---|---|
| Greenstone, | 500 |
| Trap, compact, granular and amygdaloid, | 21,000 |
| Conglomerate, | 3·50 |
| Amygdaloid, | 26·50 |
| Conglomerate and sandstone, | 32·60 |

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| | Metres. |
|---|---|
| Trap, chiefly amygdaloid, | 132 |
| Conglomerate and sandstone, | 18 |
| Amygdaloid, | 10·50 |
| Sandstone, | 8·25 |
| Amygdaloid, | 110 |
| Conglomerate and sandstone, | 183 |
| Amygdaloid, | 56 |
| Great zone of conglomerate and sandstone, | 1,660 |
| Amygdaloid, to the Lake. | |

ONTONAGON.

South-west of Portage Lake, and thence beyond the Ontonagon river, the general disposition of the strata is in a great measure the same as at Keweenaw Point. The trap forms very elevated chains of mountains, presenting a double (slope) towards the north-west and south-east, upon which the conglomerates and the sandstones rest. The alluvium covers almost all the country, leaving exposed only the summits of the mountains, and preventing the determination of the exact limits of the different formations.

The most elevated mountains are formed of porphyritic or sienitic trap, and are a continuation of the Bohemian chain. They indicate the somewhat sinuous course according to which the upheaval has taken place. Near Portage Lake this direction is N. 55° E., and S. 35° W., and further on, towards Ontonagon, it is manifestly different, being N. 65° E., and S. 65° W. On the south the crystalline and porphyritic trap passes almost immediately under the conglomerate and sandstone; in the north, it is covered by successive beds of compact, granular, amygdaloid and epidotic trap, which are separated from each other by very thin layers, or by beds of conglomerate and sandstone.

These beds are parallel to the porphyritic trap, and dip towards the north-west at an angle a little variable from 55° to 65°; their inclination is consequently much larger than that observed at Point Keweenaw.

The part nearest Portage Lake is very little known, and presents no permanent mining operations; the trap is principally compact, and not of great thickness; it is a little more than 5 kilometres towards the north, and only 2 kilometres near the path which leads from Misery river to the old Catholic mission, which was established in former times at the foot of Keweenaw Bay. The thickness of the zone of trap gradually increases towards the south-west, and near the Ontonagon river, the horizontal distance that separates the sandstone of the north and of the south varies from 6 to 8 kilometres.

The most thoroughly explored region, that to which the name of the metalliferous region of the Ontonagon has been particularly applied, extends from the Algonquin mine to the Trap Rock mine. In this part the trap forms many series of elliptical moun-

tains, which are very extended, and terminate in extensive plains, elevated 20 to 30 metres above the adjacent valleys, and from 180 to 280 metres above the level of the lake. These mountains can be distributed in three parallel chains.

The southern chain is the most elevated; many of its summits are from 250 to 300 metres above the lake. It is composed of crystalline trap, slightly porphyritic; of compact trap, which is principally observed on the southern declivity, and also of amygdaloid trap on the opposite declivity. The rock is found in thick beds, the slope of which is inverted on the opposite declivity; on the south they are covered by the conglomerate and sandstone, the layers of which are parallel, but a little broken, and dip at 50° southerly. On the other side the amygdaloid rock appears to form the entire valley of Minnesota, which is covered by argillaceous alluvium; the arrangement and inclination of the beds cannot be well observed except at the works in the second chain of compact trap.

The separation of the two varieties of compact trap is marked by two layers of sandstone and conglomerate, from 10 to 5 metres in thickness, and dipping to the north-west at an angle of 55°; the beds of trap of the two sides have the same inclination.

Between the conglomerate and the compact an extremely rich vein of copper and native silver is found, presenting many detached veins in the compact trap; they run parallel to the series, and cut the bed at a very acute angle. These veins are rich in native copper, but do not contain silver. I shall refer more in detail to their arrangement further on in these pages.

On the southern slope of the south chain analogous deposits are worked, which are characterized like the preceding by great masses of epidote, intervening between beds of trap and penetrating a certain distance in the amygdaloid. In many places, likewise, there has been observed the presence of seams of sandstone and conglomerate, indicating the separation of beds of trap of a different nature, compact and amygdaloid; the beds and seams all dip to the north-west, at an angle varying but little from 55°.

The middle chain of compact trap is less elevated than the southern; its table-land is not more than 200 metres above the level of the lake. On the north it presents a thin seam of sandstone, to which succeed beds of compact and amygdaloid trap, covered in the valley by argillaceous alluvium of great thickness, and forming the third chain, called the chain of the north.

But few explorations have been made on this side; still they are sufficient to show that the features of the trap are the same as on the south, that is to say, it appears in powerful beds,—parallel to each other, and dipping to the north-east at an angle of

50°, and at times separated by beds of sandstone or conglomerate.

The limit of the trap on the north is marked by beds of jasper, sandstones and conglomerates, upon which reposes the sandstone which appears to extend under the alluvium, even to the borders of the lake.

The trap mountains are not continuous, but consist of extended chains, separated by transverse valleys, some of which are large and deep, others narrow and shallow. The southern chain is, however, almost throughout the line of separation of the waters, and the valleys through which the streams find a passage in flowing northerly to the lake are evidently the result of fractures of the strata. The most remarkable is the valley of the Ontonagon river, the western branch of which flows at the foot of the southern side of the trap from Lake Agogebic.

The line of the chains is not always regular as applied to a particular ore; the differences are observable principally in the valleys analogous to that of the Ontonagon, and indicate the position of the principal faults which should extend in a normal direction to the beds of trap; they have an evident relation to the charges and inspections which that direction presents.

These faults have not as yet been well examined, but their importance is so great that the attention of the superintendents of mines must be soon called to them.

In the works undertaken in the Ontonagon region, the deposits situated in the medial chain, in the same position as those of the Minnesota, the copper is much more abundant and in much larger masses than in the deposits of the south. Wherever the line of the chains has been disturbed by faults, it is very difficult to recognize the exact position of the works commenced, whilst the complete study of the systems of faults and the disturbances they have caused, will indicate whether one is placed upon the extension of the medial chain or upon a detached chain of the southern system.

West of the Ontonagon the trap assumes a nearly east and west direction, and appears at the surface over a vast extent; on the south it extends to the granite, by which it has evidently been elevated; on the north it shows itself even to the shore, in a very irregular broach, which in itself has the form of a crescent. Here are the Porcupine mountains, in which many mining explorations have been made, which have not been profitable. These mountains rise 250 to 300 metres above the level of the lake, and are surrounded by broken and elevated conglomerate and sandstone.

They are composed of two very different rocks; jasper on the south, and compact and crystalline trap on the north.

The appearance of the country, the arrangement of beds and layers of jasper, trap, conglomerate, sandstone, and the alterna-

tion of the trap and the sedimentary rocks, present the grandest analogy to all the facts observed at the eastern extremity of Point Keweenaw.

(To be Continued.)

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## Art. VI.—THE AMERICAN MINERS' ASSOCIATION.

The article in the last number of this Magazine, under the above title, has drawn out numerous responses, all of which approve of the general object. Some contain useful suggestions which appear of equal importance. Of this number we select the following, which proposes another and an excellent method of accomplishing the same object. Whichever will secure the greatest advantage to the entire mining interest of the country should be adopted.

### AMERICAN SCHOOL OF MINES.

"The suggestions of S. P. L. in a late number of your Magazine, in relation to the formation of a Mining Association, are worthy of the most earnest attention. Perhaps, however, his ultimate wishes may be gratified in another way, and as a man of science, and desirous of the progress of true practical science, I suppose he looks not so much at the means as the ends to be secured. Measures have been in progress for some months past towards the accomplishment of what I suppose S. P. L. has in view, by the organization of the American School of Mines, on a plan *mutatis mutandis* of the English, Belgian and French schools of mines. From the comparatively limited development of the mineral wealth of our country, it will be some time before our proprietors of mines and mineral deposits will fully appreciate the utility and value of these institutions, and consequently the American school will necessarily be organized on a very moderate scale with its general tendencies to foster and guide, rather than to reduce every thing to the rigid inductions of scientific and commercial values. Its object ought to be the establishment of a great central depository for all kinds of information in relation to mines and mineral deposits—a rallying point for the solution of every question relating to geographic and economic geology, mineral values, foreign and domestic, their production, exportation and importation—a place where the unscientific man can procure scientific information, where the tools and implements used in mining manipulations may be seen, or the means of procurement made known; proper book authorities and reports seen or referred to; and where models and plans of

mines, mining implements and instruments, and the whole philosophy of exploration may be developed.

"There never was a more auspicious time for such an organization than the present. The numerous State surveys have made known vast resources of mineral wealth at our very doors, public attention is actively alive to our native products and resources, and however much has been done, yet, compared with our vast and hitherto unearthed treasures, we may safely say that mining and mineral developments are yet in our country in their infancy. The American School of Mines need not and *must not conflict* with other and cognate institutions; it should be an auxiliary, a practical collaborator with the American Association of Science, in a particular department—a sort of collecting and distributing office of practical scientific mining operations. Notice will be given in the public papers of the time and place of meeting, which will probably be some time in October next."

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## Art VII.—THE PRODUCTS OF ENGLISH MINES AND COLLIERIES.

By R. G. Rankin. No. 2.

### SILVER.

Estimate of silver produced from the mines of Great Britain and Ireland in 1851.

| Mines producing lead. | Quantity of Pig lead in each per annum. | Supposed proportion of silver in each ton of lead. | Number of ounces of silver from each district. | Value at five shillings per ounce. |
|---|---|---|---|---|
| | Tons. | Ounces. | | £ |
| Cornwall, | 7,304 | 35 | 225,640 | 63,919 |
| Devonshire, | 1,026 | 40 | 41,040 | 10,260 |
| Cumberland, | 5,702 | 9 | 51,318 | 12,829 |
| Durham, Westmoreland and Northumberland, | 13,283 | 12 | 158,796 | 39,699 |
| Derbyshire, | 4,250 | none | — | — |
| Shropshire, | 2,769 | none | — | — |
| Yorkshire, | 5,228 | none | — | — |
| Cardiganshire, Carnarvonsh. and Carmarthenshire, | 3,492 | 15 | 52,380 | 13,095 |
| Flintshire and Denbighshire, | 8,122 | 7 | 56,854 | 14,213 |
| Montgomeryshire and Merionethshire, | 679 | 6 | 4,074 | 1,018 |
| Ireland, | 1,380 | 10 | 13,800 | 3,450 |
| Scotland, | 822 | 8 | 6,576 | 1,644 |
| Isle of Man, | 1,699 | 20 | 33,980 | 8,495 |
| | 55,701 | | 674,458 | 168,614 |

Robert Hunt, Esq., keeper of the Mining Records of the School, and one of the leading, practical scientific minds of Great Britain, says in his records, from which these tables are taken, that the above produce of silver must be considered as

approximation founded upon a general acquaintance with the mines of the different districts.

Estimate of lead and silver imported into Great Britain in 1850:—

| | tons. |
|---|---|
| Spanish lead, | 6,210 |
| Other lead, | 1,005 |
| Lead *ore*, 1,380 tons, lead, | 1,120 |
| | 8,335 |

Average contents of Silver estimated at 20 oz. per ton, 168,700 ounces. Value 5 shillings per ounce, £41,675.

Estimate of *silver* produced from the mines of Great Britain in 1852.

| County. | Average proportion of silver in each ton of lead. | Ounces of Silver in each district. | Value at 5 Shillings per ounce. |
|---|---|---|---|
| Cornwall, | 35 | 250,008 | 62,502 |
| Devonshire, | 40 | 91,840 | 22,835 |
| Cumberland, | 9 | 52,998 | 13,226 |
| Durham, Northumberland and Westmoreland, | 12 | 191,736 | 47,984 |
| Cardiganshire, Carnarvonshire, and Carmarthenshire, | 15 | 91,680 | 22,920 |
| Flintshire and Denbighshire, | 7 | 47,188 | 11,784 |
| Montgomeryshire, | 6 | 5,562 | 1,390 |
| Ireland, | 10 | 32,220 | 8,055 |
| Scotland, | 8 | 19,048 | 4,762 |
| Isle of Man, | 20 | 36,700 | 9,675 |
| | | 818,925 | 205,080 |

The preceding tables afford an approximate valuation of the silver contained in the lead-ores of the respective districts, and show the fallacy of the high-colored assertions and over-estimated production of silver in some of our American lead ores. The analogies in the lead-bearing formations of the two countries are striking, when undeveloped or unworked lead mine-owners assert that their particular lead-vein carries 75,100 or 140 ounces of silver per ton. We would only say "*caveat emptor*," look out for breakers.

(To be continued.)

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## COMMERCIAL ASPECT OF THE MINING INTEREST.

New York, August 18, 1856.

All through the spring and summer, the stock transactions of mining companies have been very few. The speculators, who were so active a year or two in this kind of investment, seem to have left dealing in it altogether, the prospect of gain being too slow and uncertain to retain them. Appreciation in mining stock values can only be slow; as it depends upon the progress of development in the several mines, and the prospects of returns. The old established Lake Superior mines yield more abundantly than ever, and

the stocks of the Minnesota Company and of the Cliff Company are as high as ever. Some of the other companies are making progress, but the bulk of the new companies are at a stand-still. No return of ease in the money market seems likely to restore the spirit of speculation to the mining stocks, yet the field of mining adventure legitimately cultivated would yield good returns. Outlays of capital, however, are necessarily large, and a length of time somewhat uncertain has to be calculated on for returns. The prospects of mining returns are often in a great degree delusive. The ore is seen in great quantities, but the difficulties and expense of getting it out are often overlooked. Honduras, one of the Central American States, is about to be opened to the mining adventurers of this country and of Europe. Our countryman, E. G. Squier, late Consul to Nicaragua, has been working to this end for some years. The State of Honduras, from shore to shore, is rich in mines of nearly all kinds. It extends from the Bay of Fonseca, on the Pacific, to the Atlantic shores. The ancient Spanish city of Comayagua is midway between the Oceans, on an elevated district, which gradually descends on either side to the waters, giving origin to numerous streams, east and west. This city was a flourishing one before New York was built. A company called the Honduras Railway Company has been organized here to concert mainly with French and English capitalists, for an enlarged company to work out its objects; which are not only the building of a railway, but the opening and working of silver and other mines. A number of French engineers have explored the country, on behalf of the company, and report favorably; and three Boards are to be formed—one in Paris, one in New York, and one in London, for carrying out the objects.

*The Cumberland Coal Company* has depreciated in market value considerably this year, and the shares are now below twenty dollars. The company have not yet sold any part of the property, as is projected.

*The Hampshire Coal and Iron Company* has fallen into difficulties, from want of right management, and the bond-holders have taken hold of the road, who report favorably of its prospects. Mr. Satterlie, of Pine street, has been chosen President, and the old directors have severally resigned. Many coal companies have been organized, but the projectors find it difficult to get responsible and influential men to become Presidents, and so they lie in a state of semi-formation,—bodies organized, but souls wanting.

We understand that the old North Carolina Copper Company is working steadily at its mines, and is obtaining fair returns of copper, which it sells to the Boston refiners, and is thus enabled to pay its present expenses, and hopes to do more by and by.

*The Tennessee Mines* are not doing much, at present. One or two are being worked favorably, but the greater number are lying fallow, and all are still being offered for sale in Europe. The mines have an undisputed reputation for riches.

As money gets easier in London, it is expected that sales will be effected there. Some parties are on from London to examine.

Money has been abundant in New York ever since the opening of spring; and the approaching fall is not likely to exhibit extreme stringency, though

the usual fall activity of demand will absorb the supplies very readily. Money is worth, on call, 7 per cent. Stock operators have to pay half per cent. per month, to brokers, for carrying their stocks for them, and the rate is tending upwards. Discounts of bills receivable are negotiable, at 8 to 10 per cent. for well endorsed paper of all usual dates, 90 days to 6 months inclusive. The Banks have out, on loan and discount, 112 millions of dollars, an unusual amount, while the specie held by them is but twelve and a half millions.

This state of things, at the commencement of the fall season, insures a contraction, more or less serious, in the coming months, when the movement of the crops will divert large sums to the West. The certainty of a contraction, but the uncertainty of its extent, gives rise to fluctuations, of no mean kind, in the value of stocks, on the Stock Exchange. Prices have been falling and rising, for many weeks past; but at every turn the decline is greater than the preceding one. The downward tendency alarms speculators for a rise, who are less disposed to face the speculators for a fall.

This state of things will last until it is seen how far the contraction will proceed. Money is coming in from abroad for temporary employment, which will be a set-off against the demand from the interior. Speculators for a fall act in the belief that the banks will have to contract ten or twelve millions of dollars, but the greater available resources of the country this fall over last, seem to point to a much less contraction than usual.

The exports of cereal produce this summer are larger than usual. The imports, however, are very large, and the money required for duties is very great. The importers are not remitting for them at present, and the rates of foreign exchange are heavy, at 109¼ to 109¾ for sterling exchange, at which little specie can be shipped at a profit, and that little only by houses having special facilities, on the other side, for refining.

The country has been blessed with another bountiful harvest, and the occurrence of two years of good cereal harvests and cotton crops makes it rich and saucy.

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## JOURNAL OF MINING LAWS AND REGULATIONS.

### CLAIMS OF MINING LESSEES ON LANDLORD.

*The Lehigh Coal and Navigation Company*
vs.
*Harlan and Henderson.*

ERROR TO COMMON PLEAS OF CARBON COUNTY, PENN.

THE opinion of the Court was delivered by WOODWARD J.

This is an action of covenant on a mining lease. One of the grounds assumed by the plaintiffs below (now defendants in error) was, that an owner of reputed coal lands, who leases them to a tenant as such, and induces him to make large expenditures in opening and preparing to work the veins, is liable in covenant to the tenant if the veins turn out to be worthless—that the law implies a covenant of warranty on the part of the lessor, that the

veins will be found to be worth working, and sufficient, at the least, to reimburse the expenditures of the tenant. The two first counts of the narr, and many of the points submitted on the part of the plaintiffs, are founded on this proposition, but as the Court below ruled it against the plaintiffs, and they have taken no writ of error, it is not up for review, and we allude to it only for the purpose of saying that it is not to be considered as ruled by any thing we may say on the other parts of the case.

To develope clearly the questions which are to be ruled, a brief sketch of this controversy must be first given.

The Lehigh Coal and Navigation Company owning lands in the Sharp mountain near Tamaqua, which contained, or were supposed to contain, several distinct veins of coal, entered into a lease on the 11th of March, 1842, with Denniston, Bowman & Co. for one of said veins known as the Q. vein. The lessees covenanted to make, at their own expense, all the necessary improvements for opening and working said vein, which were to be finished by the 1st of April, 1843, and their advances for which were to be reimbursed out of the first rents that should become due from them for coal taken under the said lease. The term was for seven years from 1st April, 1842, and they were to mine at least eight thousand tons of coal in each year, for which they were to pay, for large or broken coal, and for egg coal, 35 cents per ton; for pea coal, 10 cents per ton.

The memoranda subsequently attached to this lease related to details which need not be noticed here, except that the term was extended to the 1st April, 1850.

On the 29th June, 1846, the Company made another lease to some of the same individuals, under the name of John Anderson & Co., of another vein called the P. vein, for the same term, and upon the same rent, that they held the Q. vein. They were to drive at their own expense a tunnel from the Q. to the P. vein, and were to mine from the two veins not less than fifteen thousand tons per annum. On the 27th of January, 1847, the lessees assigned both these leases to the defendants in error, Harlan & Henderson, who went into possession of these two veins.

On the 12th April, 1847, the Company entered into a lease with Harlan & Henderson, which is the instrument declared on, and which leased to them for the term of three years from 1st April, 1847, "*the right and privilege to mine and take away stone coal from the veins known as the R. and S. veins, and any other veins intermediate between said veins and the Q. vein in the Sharp mountain,*" yielding and paying therefor 25 cents per ton for chestnut coal, and 50 cents per ton for all coal of a larger size, subject to a deduction on the whole of said rent of 5 per cent.

Thus by virtue of these several leases the plaintiffs below became tenants of four distinct coal veins of the Navigation Company.

They commenced mining in the two first-named veins, in February, 1847, and after the third lease, they pushed the rock tunnel from the Q. vein to the R. vein, which they reached in March, 1848. They found this vein 25 feet thick, but all in dirt fault, and after driving the gangway 415 feet in it without getting through the fault, they abandoned the vein early in December, 1848. They extended the rock tunnel on towards S. until they reached what they supposed was that vein, about a foot thick of shelly faulty coal not fit for use. According to Mr. Patterson, the Company's agent, the plaintiffs never reached the S. vein at all. From the Court's summary of the evidence, it appears that there were mined during the three years, 55,685 tons, of which 104 tons came from the R. vein—all the rest from P. and Q.—that the gross rent therefor amounted to about $14,584—that the plaintiffs paid the Company in cash $5769.95, and in houses built, $4000 more, and that they have yet in hand $5423.06 of rent.

Having surrendered the premises at the expiration of the several leases, they instituted this action to recover damages for breach of the Company's covenants as contained in clauses or sections 11 and 12 of the lease of 12th

April, 1847, which are in these words: 11. That whenever a *dirt fault* shall occur in said veins, the said Company *shall and will allow the said party of the second part a fair and just price for running* the gangways through all *such dirt faults*, exceeding *ten yards lineal*, provided, however, that soft workable coal shall not be considered faults. And, in case the rock or slate *closes in so as to cut off the coal*, and render it necessary to cut away the rock or slate, in order to obtain the necessary width of gangway, then, and in such case, the said party of the first part shall and will *pay the whole expense* of removing such rock or slate faults, they, the said party of the first part, at all times being first consulted, and approving *by their assent in writing*, of running such gangways in or through any faults.

12. That the said party of the first part *will make a fair allowance for the railroad iron*, and for the spikes necessary for laying the railroads in the main driffs or gangways upon completion of the same, said allowance to be made by deducting it from the rent *herein before stipulated to be* made; but no allowance will be made for repairs. And a *fair allowance*, to be determined by the mine agent of the party of the first part, shall also be made for *running the slope*, and doing the *other work* necessary for *opening the said veins*, provided the mode of *opening the said veins* shall have been upon a plan approved of by the engineer of the said party of the first part; the *said allowance to be made* by deducting it from the *rent herein before agreed to be paid.*

| | |
|---|---|
| Under the 11th clause, the plaintiffs claimed— | |
| 1st. For work in faults in R., driving air shafts, and improving vein, . . . . | $1549 85 |
| 2d. For driving faults in P. Q. and Q. Q., . . . . . | 4395 00 |
| Equal to . . . . . | $5944 85 |
| And under the 12th clause, for timber and construction of shutes and screen building for office, new shutes and fixtures, embarkment of railroad, rock tunnel, driving slopes, and railroad iron in gangways of P. and R. and outside, . . | $15,099 04 |

There was evidence that the work had been done and the materials furnished, for which the plaintiffs claimed, but defence was taken on several legal grounds, the most important of which I proceed now to state and consider.

1. It was said that the lease of 1847 contains, upon a proper construction of it, no covenant for payment for any work done upon the P. and Q. veins by the plaintiffs.

The Court was of opinion that that instrument was a lease only of the R. and S. veins, but that it contained covenants which reached beyond the veins immediately demised, and embraced the P. and Q. veins, and that the plaintiffs might recover under it for work done upon these veins.

To get at the meaning of the words "*said veins*," as they occur in the 11th and 12th sections, it is necessary to trace them back through the whole context to the premises, and there we have seen already, what the learned Judge below admitted, that the thing demised consisted of the R. and S. veins. But in the first covenant which follows the formal parts of the lease proper, it is provided that "the said party of the second part shall mine and take away from the said veins, and from the P. and Q. veins now in possession of the said party, at least fifty thousand tons of coal in each and every year during the continuance of this lease, provided the said veins, by all proper management, can be made to yield or produce said quantity of coal," and it is supposed that here the four veins were so run together and blended, that all the subsequent covenants concerning "said veins," refer to the four instead of the two veins—that there was, in fact, a merger of the two former leases in this one.

We cannot take this view of the matter. For the two purposes of fixing the whole production of the four veins, and making the rents under the three leases payable at one and the same time, this article of the lease does unite the P. and Q. veins with the R. and S. veins, and does so far modify the for-

mer leases. But this is the whole effect of the covenant. A similar instance is found in the prior leases. By the lease of 1842, 8000 tons per annum were stipulated for from the Q. vein, and when the lease of 1846 was made for the P. vein, it stipulated for a joint production from the "*two veins*," of a quantity not less than fifteen thousand tons per annum. Now nobody ever supposed that this was a merger of the lease of 1842, in that of 1846,—these plaintiffs certainly did not think so in January, 1847, when they took assignments of each of these leases as still subsisting. Why, then, when a third lease is made on the same principle, should it be accounted a merger of the two former? Where the same parties are carrying on mining in several veins belonging to the same landlord, and the covenants bind them to work in all the veins, it is advantageous to both parties to fix the rate of production in such manner, that if one vein will not yield it, another may—to the landlord, that he may be sure of his anticipated rent—to the tenant, that he may obtain profit on the largest possible amount of coal.

Some of the veins may run into fault, whilst increased mining may be carried on in others—or, for many other reasons, preparatory work may have to be done in one vein which shall suspend mining therein, while the tools and implements for mining in that vein may be profitably employed in another. A rigid rule that should require a given number of tons from each vein, would lead to frequent disappointment and difficulty, whilst one that fixes the aggregate of all the veins, admits of adaptation to those unforeseen circumstances, which, in this business, are always occurring. It was, we suppose, for the purpose of guarding against contingencies in one vein or another that might affect the gross production, as well as to make all the rents payable at one time, that this covenant was introduced into the lease of 1847, and its whole scope and effect are to be limited to these objects.

The next succeeding covenant proceeds to distribute the rights and duties of the parties under numerical heads or sections, from 1 to 13 inclusive; and when the expression "said veins" occurs in these sections, we are to understand it as referring not to the four veins grouped in the covenant we have been considering for the special purposes stated, but to the two veins which are the subject matter of the lease. Established rules of construction require all covenants of detail to be referred to the premises, unless a different reference be clearly indicated by the language used. Here there is nothing to manifest an intention to merge the former leases, and the details arranged throughout these thirteen articles cannot apply to the P. and Q. veins; for they are inconsistent, in some points, with the regulations prescribed by the former leases for those veins. For instance, it is covenanted in the 4th article, that the lessees will at their own expense make all the necessary improvements for "opening and working *the said veins*"—a provision which it would be absurd to apply to veins already opened, and in which the party promising was then actually engaged in mining. But if the expression, "said veins," refers exclusively to the R. and S. veins in the 4th article, what warrant have we for saying that the same words, when used in the 11th and 12th articles, include the P. and Q. veins? Obviously none. Covenants, like all other contracts, are to be construed according to the intentions of the parties as nearly as the words will permit, and there is no surer guide to the understanding and intentions of the parties, when words are equivocal, than their acts and declarations under the agreement, called commonly its contemporaneous construction. The conduct of these parties, and especially their correspondence, proves that they understood the lease of 1847 as we have expounded it. We feel great confidence, therefore, in our conclusion, that sections 11 and 12 have no reference whatever to the P. and Q. veins, but that improvements and work in these veins were left to stand for compensation upon the provisions of the prior leases. It may be added, that the diversity of rents under the several leases is a strong reason against the assumption of a merger. 2. The next objection taken to the plaintiffs' recovery was, that they having agreed to look for payment for work done upon the R. and S. veins to com-

pensation, by an allowance to be made out of the coal rents agreed by them to be paid to the Company, cannot claim for said work out of any other fund than one arising from rents of the said veins.

We construe the "allowances" of the 12th section to relate to the work provided for in sections 4, 7 and 8; and these allowances, it is expressly stipulated, are to be made from the rents herein before agreed to be paid, which, according to our construction, mean the rents to accrue from the R. and S. veins. The Company seem to have provided, by their several leases, that each of their coal veins should pay for its own development. And this is according to the usual course of mining leases. The landlord has invested his money in the title of the coal land—the tenant is expected to invest his in opening and working the veins. Both look for their reimbursements to the coal to be mined; the tenant, generally, as in the instance before us, expecting the first fruits, and these to be gathered by deductions from the rent —the landlord, to obtain his rent unimpaired after the improvements have been paid for. The lease of 1847 seems to have been constructed on these general and familiar principles. But who is to bear the disappointment when veins thus opened prove inadequate to reimburse the outlays? If the tenant may charge the expenses against the accruing rent of *other* veins held of the same landlord, he may charge the landlord personally, and then a mining lease, without an express covenant to that effect, amounts to a warranty that coal will be found sufficient to reimburse the cost of opening.

The court below held that no such covenant could be implied; and as this opinion is not complained of, we are to take it for the present as correct. In support of it there is one consideration of considerable weight that might be urged.

Mining is so much an act which involves necessarily many of the principles of mineralogy and geology that tenants, who take leases of this sort, are generally more capable of judging correctly the quality of coal veins than the landlords of whom they lease. It is no uncommon thing indeed to find, in the mining districts, men who never read a page of any scientific book, but who, bred up to the business of mining, understand all the peculiarities of coal veins better, and can reason, *à priori*, on their probable yield more soundly, than the most learned professor who has had no practical experience. Hence it is, that when a miner, and an owner of coal lands who is not a miner, come together to treat for a lease, the advantages which always belong to superior knowledge are on the side of the tenant. If he have doubts of the vein to be worked, he knows how to prove it before his expenditures are made or stipulated to be made. He is not the party who stands in need of legal implications for his protection, and if he is content to go on without an express covenant of warranty, it will be a grave question, to be decided when it arises, whether he does not go on at his own risk without an implied covenant in his favor. However this may be in general, we must assume that it was so in this instance; and then it is clear, from the construction we have adopted, that the plaintiffs agreed to look for the allowances mentioned in the 12th article, to the rents to accrue from the R. and S. veins. The mistake which the court made in holding that the covenants sued upon reached beyond the premises leased in the instrument containing the covenants, led them to the illogical result of holding the landlords liable for the tenants' mistakes, while at the same time they decided that the tenants took the veins "*subject to the ordinary risk of mining, without any covenant, express or implied, of the existence of coal, or of the quantity, or of the quality of coal.*"

The rent of these veins was to be measured by applying the stipulated prices to the number of tons mined. These tons were to be added to the production of the other veins to make up the stipulated aggregate of 50,000 tons from all the veins; but for the purposes of the rent they were to be estimated separately. This must have been so, because the rate of compensation was different from that fixed in the prior leases for the P. and Q. veins. And there was no difficulty in keeping a separate account of the production of the

R. and S. veins. It was necessary, in settlement with the hands employed, and in point of fact, it was done, as appears by the exhibit in the paper books of the mining operations, from April 1, to July 1, 1848. To that separate account, and only to that, we hold the allowances stipulated for in section 12 were chargeable.

But the allowances and payments contemplated in the 11th section stand on a different footing. These were to be made for dirt faults and rock faults; and upon our construction, for such faults in the R. and S. veins only. Of course compensation was not recoverable in this action for rock, slate or dirt faults in P. Q. or Q. Q., and between these veins and the R. vein no intermediate veins were found. Nor were the slope and rock tunnel to be compensated in damages, for these were to be made by the tenants "*at their own expense*," and to be allowed for under the 12th section by deductions from the rent accruing in the R. and S. veins. But for the dirt, slate and rock faults, that should be encountered in driving the gangways of R. S., compensation was to be made—and that generally—and not out of accruing rents or any other particular fund. An important qualification, however, applicable to all these faults, was that the Company were first to be consulted, and to approve "*by their assent in writing of running such gangways in or through any faults.*

Here two other grounds of defence are brought to view. In the first place, it is said, for the work done in faults, the plaintiffs cannot recover, because it was done by the written assent of the Company; and secondly, that the abandonment of the work by the plaintiffs was a complete bar to any claim made by them under the lease.

If either of these objections is well founded, the plaintiffs were not entitled to recover by virtue of the 11th section—if both, they were doubly barred.

There is no dispute, that whatever faults were worked in R. were worked without the written assent of the Company, but it is insisted, and so charged in the declaration, that the defendants waived and dispensed with the requirement of their assent in writing. Suppose they did, would *covenant* then lie upon a sealed instrument so modified by parol? Let it be noticed that this was not a condition precedent to be performed by the plaintiffs, and which the defendants might have waived by parol without impairing the integrity of their covenant, or the plaintiffs' right of action thereon, but it is part of the very covenant sued on—one of the conditions on which the doing of the work, and the consequent liability of the defendants, were suspended, and if it was changed by parol, the plaintiffs' action should have been assumpsit and not covenant. The distinction is taken in Vicary *vs.* Moore, 2 W. 457, and followed in other cases, between an alteration of the plaintiffs' stipulations, being but conditions precedent to the action, and those of the *defendant* on which it is directly founded. The performance of the first may be waived, so as to entitle the plaintiff, without more, to an action on the defendants' covenants, but to sustain a count based specifically on covenants modified by parol, would require us to give to the whole the quality and effect of a specialty The cases of Greene *vs.* Roberts, 5 Wh. 84, and M'Combs *vs.* M'Kennan, 2 W. and S. 218, cited in argument, are referable to this distinction.

The law of all the cases is, that when a plaintiff sues on a covenant which has been modified by parol in a point essential to the defendants' liability, the action should be assumpsit, "the written contract being treated as abandoned, or used no further than to mark the terms and extent of the new stipulations."

Now the defendants in this case covenanted to pay for work that should be done under their written assent.

They are sued on that covenant, and it is alleged, as a part of the plaintiffs' case, that the written assent was dispensed with, and the parol assent substituted, and this alteration of the covenant, if ever made, was by parol. The contract, then, is no longer the covenant that was sealed, and the remedy must change with the contract. It is suggested that the action of covenant in Pennsylvania is an equitable action. Before our equity powers were full

blown, this action was sometimes made to answer the purposes of a bill in equity. and now, under a plea of covenants performed with leave, &c., an equitable defence may be given in evidence; but the action, considered in reference to the kind of instrument on which it may be brought, is strictly an action at law upon a contract under seal. A party who brings such an action and cannot make out a breach of the defendants' covenant as it stands written, signed and sealed, has no case in a court of law. To bring down the covenant to parol in order to suit his evidence, is to defeat his action. It is apparent from all this case, however, that there never was a parol modification of the defendants' covenant. The lease stipulated that the mining should be done under the eye of the defendants' agent; and the plaintiff proved that *he* assented to the work for which they claim damages.

In the pleadings, their case was that of a covenant modified by parol—in the evidence, that of a covenant performed, not according to its tenor, but to the satisfaction of the defendants' agent. The agent denies his assent, and on this point, as is usual with parol evidence, there is conflict. It was to exclude such a conflict, that the parties stipulated for the *written* assent; not of an agent of the Company, but of the Company themselves. There was no proof that the agent had authority to waive this stipulation.

What, then, did his acquiescence amount to?

At most to an implied assumpsit, on which the Company may possibly be liable for a *quantum meruit;* but it is too clear for argument, that the acquiescence of the agent could not make them liable in covenant on the sealed instrument. Covenanting to pay for such work only as should be done under their written assent, they are not liable in this action for work done under the mere oral assent of an agent. It would seem that the parties contemplated the occurrence of faults as a possible, but not very probable contingency. The plaintiffs bound themselves to push on their gangways with "all proper management, means, effects, and exertions;" and if faults should occur, they might cut through them at their own expense, without consulting the Company, for the sake of reaching the coal; or if they meant to charge the Company, they should give the Company an opportunity to decide on prosecuting or abandoning the work, and their written assent to its prosecution should be the evidence of the corporate liability to pay for it. That the fault was to be tested before the Company should be called on to decide whether to stop or proceed, is shown by the provision, that *ten yards* lineal mining into the fault was to be done by the plaintiffs without compensation, and the excess only to be paid for by the Company, and that after being first consulted, and approving by their assent in writing.

When the plaintiffs undertook to work beyond the ten yards without the stipulated consultation and assent, they did that which was lawful and proper, and which seemed, perhaps, to be best for their own interests; but which they knew, if they ever read their own agreement, would not make the Company liable to them.

The other ground of defence, that the abandonment of the work before the expiration of the term named in the lease was a bar to the action, need not be discussed, for the point last noticed is decisive against the plaintiff's right on the 11th section.

Nor is it necessary to consider another question suggested, whether, under the pleadings, the plaintiffs could recover back money once voluntarily paid; for the only ground on which they are entitled to recover at all, is that which is found in the 12th section, and that is limited to the rents which accrue in the R. vein. But they have, confessedly, in their hands, more of the company's money than these rents amounted to, so that they were not entitled to a verdict on the only ground that their action had to rest upon.

It is obvious, that the construction we have given to the lease would have led to the rejection of the evidence mentioned in the first error assigned, and to instructions that would have prevented a recovery. It may be true *that we are administering a severe measure of justice*, but the plaintiffs made

the contract such as it is, and if there be hardship in the case, it is self imposed. Courts of justice are doing their appropriate work, when they hold parties to the plain meaning of their written contracts. We only expound and enforce that which they agreed should be the rule of their conduct.

The judgment is reversed, and a venire de novo is awarded.

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# COALS AND COLLIERIES.

## ANTHRACITE COAL TRADE FOR 1856.

| | | |
|---|---|---|
| Shipments by Reading Railroad to June 21st, | 949,274 09 | tons. |
| " Schuylkill Canal, | 368,346 05 | " |
| | 1,317,620 14 | " |
| Same time last year, | 1,444,226 00 | " |
| Decrease to June 21st, | 126,605 15 | " |
| Delaware & Hudson Canal, to June 14th, | 95,500 | " |
| Same time last year, | 127,792 | " |
| Pennsylvania Coal Co., to June 14th, | 94,482 | " |
| Same time last year, | 118,464 | " |

## LEHIGH COAL TRADE TO JUNE 14, BY CANAL.

| | | |
|---|---|---|
| Summit Mines, | 76,166 15 | tons. |
| Room Run Mines, | 15,575 07 | " |
| East Lehigh Mines, | 7,9..3 09 | " |
| A. Lathrop's Pea Coal, | 616 02 | " |
| Spring Mountain Mines, | 29,298 13 | " |
| East Sugar Loaf Mines, | 19,569 01 | " |
| Colerain, | 19,231 16 | " |
| Stafford, | 4,722 14 | " |
| N. Y. Lehigh Coal Co., | 11,379 07 | " |
| German Pennsylvania Coal Co., | 7,636 01 | " |
| South Spring Mountain Ridge, | 1,596 14 | " |
| Connell Ridge, | 11,667 08 | " |
| Hazleton Coal Co., | 30,892 04 | " |
| Cranberry Mines, | 16,480 06 | " |
| Diamond Mines, | 9,706 15 | " |
| Buck Mountain Co., | 28,123 17 | " |
| Wilkesbarre Coal Co., | 8,723 15 | " |
| Wyoming Coal, | 1,455 11 | " |
| Total, | 295,969 00 | " |

### *Lehigh Valley Railroad.*

| | | |
|---|---|---|
| Wm. Milnes & Co., | 32,197 16 | tons. |
| Ratcliff & Johnsons, | 428 17 | " |
| Packer, Carter & Co., | 2,955 14 | " |
| N. Y. & Lehigh, | 892 00 | " |
| James Taggart, | 2,778 09 | " |
| Sharpe, Leisenring & Co., | 9,187 01 | " |
| Total, | 47,551 17 | " |
| By Canal, | 295,969 00 | " |
| Total, | 343,490 17 | " |
| Same time last year, (Canal) | 357,972 19 | " |
| Decrease in 1856, so far, | 14,532 02 | " |
| The decrease by Canal is | 61,903 19 | " |

PRICES OF COAL.

The following are the prices fixed for Lehigh coal on board at Bristol:

| | |
|---|---|
| Lump, | $4 75 |
| Broken, Egg and Stove, | 4 50 |
| Chestnut, | 3 75 |

All coal taken before the first of July is entitled to a drawback of 25 cents from these rates.

The Delaware and Hudson Canal Company's circular fixes the price of coal at the following rates on board at Rondout:

| | *July* 1. | *Sept.* 1. | *After Sept.* |
|---|---|---|---|
| Furnace Lump, | $4 25 | $4 35 | $4 45 |
| Steam Lump, | 4 35 | 4 45 | 4 55 |
| Grate (Broken), | 4 45 | 4 55 | 4 65 |
| Egg, | 4 60 | 4 70 | 4 80 |
| Stove, | 4 70 | 4 80 | 4 90 |
| Chestnut and Pea, | 3 70 | 3 80 | 3 90 |

The circular states that there is no Egg or Stove coal for sale at present.

The Pennsylvania Coal Company's circular fixes the price of Pittston coal on board at Port Ewen as follows—for cash:

| | *July* 1. | *Sept.* 1. | *After Sept.* |
|---|---|---|---|
| Lump, | $4 25 | $4 35 | $4 45 |
| Steam, | 4 40 | 4 50 | 4 60 |
| Grate, | 4 40 | 4 50 | 4 60 |
| Range, | 4 60 | 4 70 | 4 80 |
| Nut, | 4 60 | 4 70 | 4 80 |
| Chestnut, | 3 70 | 3 80 | 3 90 |
| Pea, | 3 10 | 3 20 | 3 30 |

The additional price delivered to New York from the above mentioned ports, Rondout and Port Ewen, is 50 cents per ton.

The following are the rates of prices promulgated by the Lackawanna Railroad and Coal Company.

*Prices for Lackawanna Coal delivered on board of Vessels at Elizabethport to November*, 1856.

| | *To July.* | *Aug.* | *Sept.* | *Nov.* 15. | |
|---|---|---|---|---|---|
| Lump, | $4 35 | $4 40 | $4 45 | $4 55 | per 2240 pounds. |
| Steamer, | 4 50 | 4 55 | 4 60 | 4 70 | " |
| Grate, | 4 50 | 4 55 | 4 60 | 4 70 | " |
| Egg, | 4 70 | 4 75 | 4 80 | 4 90 | " |
| Stove, | 4 70 | 4 75 | 4 80 | 4 90 | " |
| Chestnut, | 3 70 | 3 75 | 3 80 | 3 90 | " |

The above prices are for cash.

The above company mine their coal in the Lackawanna Valley, between Scranton and Carbondale. Their mines are at Jessup. They are new. The company ship over the Delaware, Lackawanna and Western Railroad Company's road, with which they intersect, about seven miles from the mines.

## *Delaware, Lackawanna and Western Railroad.*

*Scranton Coal delivered on board of Vessels at Elizabethport, N. J., during the year* 1856.

| | *To June.* | *July.* | *Aug.* | *Sept.* | *Oct.* | *Nov.* | *Dec.* |
|---|---|---|---|---|---|---|---|
| Lump, | $4 40 | $4 45 | $4 50 | $4 55 | $4 60 | $4 65 | $4 70 |
| Steamboat, | 4 55 | 4 60 | 4 65 | 4 70 | 4 75 | 4 80 | 4 85 |
| Large Egg, | 4 55 | 4 60 | 4 55 | 4 70 | 4 75 | 4 80 | 4 85 |
| Small Egg, | 4 75 | 4 80 | 4 85 | 4 90 | 4 95 | 5 00 | 5 05 |
| Foundery Lump, | 4 75 | 4 80 | 4 85 | 4 90 | 4 95 | 5 00 | 5 05 |
| Stove or Nut, | 4 75 | 4 80 | 4 85 | 4 90 | 4 95 | 5 00 | 5 05 |
| Chestnut, | 3 85 | 3 90 | 3 95 | 4 00 | 4 05 | 4 10 | 4 15 |

CUMBERLAND COAL TRADE FOR THE YEAR TO JUNE 28TH.

| | |
|---|---|
| Cumberland Coal and Iron Co. | 32,059.03 |
| Percy & Co. | 5,760.12 |
| Artna Coal Co. | 4,598.04 |
| Frostburg Coal Co. | 70,524.09 |
| Borden Mining Co. | |
| Allegany Mining Co. | |
| Carbon Hill Coal Co. | |
| Wellersburg Coal Co. | |

*From the Westernport region up to June 21.*

| | |
|---|---|
| George's Creek Coal Co. | 40,943.06 |
| Swanton Coal Co. | 15,847.02 |
| American Coal Co. | 21,997.03 |
| Franklin Coal Co. | 11,866.00 |
| Lonsconing Coal Co. | 10,849.11 |
| Hampshire Coal Co. | 12,451.00 |
| Total, | 275,861.06 |

THE CUMBERLAND COAL TRADE.

Some very interesting facts respecting this coal trade will be found in the following summary of a Report to the City Council at Baltimore:

The intention of the Baltimore and Ohio Railroad Company to increase the freights on Cumberland coal transported to the city over that road, some time since, led to the appointment of a committee, by the City Council, to investigate the nature and progress of the Cumberland coal trade on that road. The committee appointed for that purpose submitted a report, in which it is stated that the Cumberland coal trade, which had bid fair to become one of the largest branches of business in the city, has, within the last year, received a serious check, and nearly all the companies engaged in it have been contracting at a loss in order to furnish employment to their miners, and thus prevent their leaving the mines until a better state of things could be brought about.

Large quantities of Liverpool and Nova Scotia coal have been imported into the eastern cities at rates which could not be competed with by our companies, and in frequent instances at a less price than that at which Cumberland coal could be delivered from the wharves at Baltimore. We have therefore to note the falling off in the total receipts of bituminous coal at our port of 61,329 tons during the year ending 31st December, 1855.

The Cumberland coal has another competitor in the anthracite coal when used for steam purposes, if the price is advanced by high rate of toll beyond the present limit. The coals of Pennsylvania are now selling in New York (the great market for Cumberland coal) at $4.50 per ton on board vessels, and the Cumberland at $5.75 per ton. This difference consumers are willing to pay, but when it exceeds $1.25 per ton they consider anthracite the cheapest and give it the preference. The committee are satisfied that the commercial interests of the city of Baltimore are deeply interested in this important subject, and think that the directors on the part of the city should use all the power vested in them to prevent any further increase on tolls on that road on coal, and use every effort to concentrate the trade to the city, instead of allowing it to be diverted to Alexandria by the canal.

The committee also state that a railroad has been completed from the Cumberland coal field to Philadelphia, and are of opinion that an increase of tolls on the Baltimore and Ohio road will enable consumers to get their coal at Philadelphia at less prices than at Baltimore, thus depriving this city of the tonnage of 100,000 tons of coal per annum.

In order to show some of the advantages accruing to the city of Baltimore by this trade, the committee present a tabular statement, from which it appears that the total receipts of coal over the Baltimore and Ohio Railroad during the past ten years is 2,013,941 tons. The amount paid the Company for freight during that period is $4,380,509.74; wharfage at Locust Point $120,837.06; cash disbursements by vessels $770,969; cash paid shipping charges, for labor, &c., $151,616.63; cash commissions to brokers $92,841.35; cash paid for repairing vessels $230,140; cash paid by vessels for harbor dues and port charges $34,521; amount of capital invested by improving property at Locust Point $295,000. During the ten years 11,507 vessels have been employed in shipping the coal.

In the beginning of the coal trade, in 1844, the charge per ton from Cum-

berland to Baltimore was 8.66; a special contract was made the same year at 1½ cents per ton per mile. In 1846–47, the rates were $2 60, $2.61a2.62 to different parties according to distance. In 1848 to all parties $2.60. In 1851–52 it was $2.05; in June, 1852, it was fixed at $2.06 to Baltimore proper and at $1.81 to Locust Point. In December, 1853, the present charge of $2.56 to Locust Point and $2.81 to Baltimore was established.

An additional charge of 20 to 40 cents per ton over the present rates being contemplated, the committee recommend the adoption of a resolution instructing the directors on the part of the city to use their efforts to prevent the freight on Cumberland coal being increased; and declare that a strict adherence to such a course of policy would be vastly beneficial to the interests of the city as a stockholder, as well as in her corporate capacity.

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### INFLUENCE OF GRADES ON ROADS TRANSPORTING COAL, AND THE ROUTES FROM THE ANTHRACITE REGION.

[Continued from page 337.—Vol. VI.]

As there has been much discussion within the past six months as to the relative cost of transporting coal on several of these routes, it is proposed to examine that subject briefly, and with a single eye to obtaining correct and reliable results.

The transportation of coal by railroad being purely mechanical, should be as susceptible of correct mathematical deductions as such operations generally are; nevertheless, we find the attention of capitalists invited to numerous arrays of figures, which, on careful examination, will be found to produce very different results from the same proposition. There is too much speculation, too much theory, and too little fact brought to bear on the subject generally; and, indeed, the facts are not in the hands of all on which to base correct calculations, for, although the reports of various railroad companies are accessible to all, they are not unfrequently misunderstood by those who desire to make use of the statements, owing to some peculiarity in the system of accounts with which they are not familiar.

The calculation to which I am about to invite your attention is based on the workings of the Philadelphia and Reading Rail Road during the last five years. This is undoubtedly a great and accurate basis for calculation; it is the actual cost of transporting upwards of 9,000,000 of tons of coal 93 miles over a virtually level railroad, during a period which takes in the extremes of high and low prices of wages and materials. It is the cost of transporting the last half of nearly double that quantity, and the period has been marked by a careful separation of the cost of coal from other transportation, and by a more detailed and accurate system of accounts than is usual with rail road companies at the present day. The wear of rails, so far as it is due to coal tonnage, is included in the cost of working, and it is believed a fair average of that charge is embraced. The uncertainty of all calculations as to grade results, which are based on small experiments, is well known in physical science. Whilst the reliable character of deductions which descend in the scale of magnitude is equally well understood; and, on this ground, the views which will be presented are entitled to especial reliance.

Previous to making use of this data, it is necessary to separate those charges which are due to running the trains per mile; those which are due to the transportation of coal per ton, independent of motive power, and those which are due to the repair and renewal of the road, &c. Instead of the last, two new headings will be found in the accompanying tabular statement, marked A. One of which is a charge to the tonnage "on which 10 per cent. is to be added for grades of 25 feet per mile" (and for higher grades in proportion), which is, the renewal of rails, raising and repairing track, &c., and is chiefly due to the increased weight passed over the road by the additional number of *locomotives* required to work on undulating roads; and the other, "Constant

charges per mile of road," such as police, and obstructions, or deteriorations from atmospheric causes.

Having divided these charges under suitable heads, they can by applied to any coal-bearing rail roads, making due allowance for such grades as govern the loads of locomotives, and for this I have prepared another tabular statement, marked B, in which the power of engines on various grades is given.

In considering the effect of grades on the cost of transportation, we not unfrequently see it stated, that it is the cost of running the engines alone, which is chargeable to grades; or, in other words, that this particular charge only is subject to an increase due to the decreased load, and that all others are in proportion to the tonnage.

However correct this view may be in its application to roads for the accommodation of promiscuous freight and passengers, it does not reach the peculiarities of those which are designed for the coal traffic, as all such roads must, and that before many years, be worked up to their full capacity, and their *ultimate capacity* is the important element in the calculation which seems to have been overlooked. It is evident that the measure of the capacity of a rail road is not so much the number of tons, as the number of trains which may be passed over it, and if from adverse grades, or other causes, the trains are reduced one-half in weight, the capacity of the road must be proportionably reduced, and the "cost and charges" per mile of road, are consequently doubled per ton carried, compared with a level road.

An eminent engineer, in a recent analysis of the cost of working several rail roads, gives the following figures as the cost of repairs and renewal, per mile, run by the trains:—

| | |
|---|---|
| Baltimore and Ohio, | 23½ cents. |
| New York and Erie, | 18½ " |
| New York Central, | 21½ " |
| Philadelphia and Reading, | 17½ " |

This is correct as regards the Reading, taking the entire movements of trains into view, but a large figure is due to the coal trains on account of their greater weight. On the first three roads mentioned, there is not one-fifth the amount of tonnage passed that there is upon the Reading, and yet the repairs, per mile, run on the latter is the least, notwithstanding the great weight of a majority of its trains. This is owing to the constant charges decreasing per mile run, as well as per ton carried, as the business increases, and owing to the large business of the Reading; it will be seen that the full cost of repairs per mile run by trains is not sufficient to cover that charge on roads of lighter trade, and hence the error of making this peculiar charge in proportion to the tonnage, as is usual with the advocates of undulating roads. It becomes, then, a matter of importance in comparing the cost of coal transportation by rail road, to first establish the ultimate capacity of the road in question, and to apply the constant charges to the proportion of its capacity which it is intended to estimate. In estimating this capacity, I again refer to the Reading; it was originally estimated by its engineer, that with two tracks it could carry 4,000,000 tons annually to market. After reaching nearly two and a quarter millions, no reason is seen to doubt its power to accommodate the remaining one and three-quarter million; yet it would seem as if its limit with two tracks will be about that amount, as the numerous trains which will be necessary to accommodate so large a tonnage, and the increase of passengers and promiscuous freight resulting from it, will leave not more time between their passage than is necessary to keep the road in repair. I have, therefore, taken the capacity of a level double track rail road at 4,000,000 tons; and as it is the trains, and not the tonnage, which is the governing feature, it is evident that the capacity of a road will be in exact proportion to the load which a locomotive will carry over it.

By reference to the accompanying tabular statement, marked B, it will be seen that grades of 25 feet per mile against the trade, reduce it to 1,000,000

grades of 50 feet to 1,200,000 of tons, &c., and that the rate of decrease is much more rapid at the head than at the foot of the column.

I have taken the angle of friction at 25 feet per mile, which is more favorable for undulating roads than 22 feet, as occasionally used, and it is more nearly the standard of practice. The average load for a locomotive I have taken at 437 tons, which is the result of the last year's workings on the Reading, and the best result thus far obtained on that road; at the same time, it must be admitted that rather better results than are shown in the statement may be attained for steep grade roads, by a peculiar adaptation of engines to the grades, but it will not amount to a great deal in the aggregate, or change the general truthfulness of the results.

The average work of the Reading for the five years was 1,816,813 tons per annum, or something less than half its ultimate capacity; the figures are, therefore, due to half the capacity of any other road which may be under consideration, *and all less quantities than the half capacity will be carried at greater cost.*

New rail roads and their machinery require for the first five to seven years of their existence, comparatively but little repairs, and it is quite possible, indeed it is usual for those who are engaged in conducting them, to be led by that fact to the belief that the cost of transportation is less than it afterwards proves to be. I am convinced that it is not safe to anticipate more favorable results than are herein indicated, and shall be glad if the effect is to guard against too low charges for coal transportation.

Without troubling you with further details but leaving those who may desire it, to follow me in the calculations from the data given, I respectfully submit the following as the cost of transporting coal on roads of various grades, exclusive of drawbacks, or of interest on capital:—

*Level Roads—Average net load, 437·3 tons.*

| | | | |
|---|---|---|---|
| Capacity, 4,000,000 tons. | No. of trains, 9,149. | Cost per ton per mile, | ·65 cents. |
| Half, 2 000,000 " | " 4,574. | " | ·69 " |
| Quarter, 1,000,000 " | " 2,287. | " | ·75 " |

*Grades of 22 feet per mile—net load, 233·5 tons.*

| | | | |
|---|---|---|---|
| Capacity, 2,118,449 tons. | No. of trains, 9,149. | Cost per ton per mile, | ·90 cents. |
| Half, 1,056,794 " | " 4,574. | " | ·92 " |
| Quarter, 528,868 " | " 2,287. | " | 1·04 " |

*Grades of 25 feet per mile—net load, 205·7 tons.*

| | | | |
|---|---|---|---|
| Capacity, 1,881,951 tons. | No. of trains, 9,149. | Cost per ton per mile, | ·92 cent |
| Half, 940,975 " | " 4,574. | " | ·99 " |
| Quarter, 470,488 " | " 2,287. | " | 1·13 " |

*Grades of 50 feet per mile, net loads 128·8 tons.*

| | | | |
|---|---|---|---|
| Capacity, 1,178,893 tons. | No. of trains, 9,149. | Cost per ton per mile, | 1·31 " |
| Half, 589,196 " | " 4,574. | " | 1·42 " |
| Quarter, 294,598 " | " 2,287. | " | 1·64 " |

*Grades of 55 feet per mile, net loads 119·1 tons.*

| | | | |
|---|---|---|---|
| Capacity, 1,089,646 tons. | No. of trains, 9,149. | Cost per ton per mile, | 1·38 " |
| Half, 544,823 " | " 4,574. | " | 1·50 " |
| Quarter, 272,411 " | " 2,287. | " | 1·78 " |

In applying these figures to the several routes, I shall assume that the cost of water transportation by the Delaware and Raritan Canal is 4-10, and by river navigation 3-10 of a cent per ton per mile. Charging those roads which have a change of motive power, with 10 cents per ton as an equivalent to that inconvenience, and considering them all working to ⅓ capacity.

It will be observed that the charges for transportation on the canal do not include repairs or lock tending, whilst the rail road charges cover all expenses except interest on capital The results are as follows:—

*By the Lehigh Valley and Belvidere Delaware.*

| | |
|---|---|
| 95 miles of level road, at 69 per ton, | 965 55 |
| Change of motive power, | 10 00 |
| 37½ miles of canal navigation, at 4 | 15 00 |
| 24 miles of river navigation, at 3, | 10 20 |
| Cost per ton from Mauch Chunk to New York, | 100 75 |

*By the Philadelphia and Reading Railroad.*

| | |
|---|---|
| 96½ miles of railroad, at ·69 per ton, | $64 89 |
| Grade against the trade, | 1 84 |
| 45½ miles of canal navigation, at ·4, | 17 40 |
| 50½ miles of river navigation, at ·3, | 17 85 |
| Cost per ton from Mt. Carbon to New York, | 101 50 |

*By the Lehigh Valley and New Jersey Central Railroad.*

| | |
|---|---|
| 45½ miles of level railroad, at ·69 per ton, | $31 05 |
| Change of motive power, | 10 00 |
| 62½ miles of adverse grades of 23 feet, at ·92 per ton, | 58 42 |
| 12 miles of water, at ·3 per ton, | 3 60 |
| | 103 58 |

*By the Delaware, Lackawanna and Western, and New Jersey Central Railroad.*

The first section of this route is about equivalent to a grade of 55 feet per mile against the trade, and as such I shall consider it, although a different system of working (which will not, probably, prove less costly) is anticipated by its projectors: so considered, its cost will be as follows, viz:—

| | |
|---|---|
| 83½ miles of railroad grades 55 feet, at 1½ cts., | $125 62 |
| Change of motive power, | 10 00 |
| 47½ miles of railroad grades 23 feet, at ·92, | 43 26 |
| 12 miles of water, at ·3 per ton, | 3 60 |
| Costs per ton from Scranton to New York, | 183 15 |

When this road is in full operation, and the tunnel finished, some 10 cents per ton may be saved by a different system of working from that contemplated in the estimate. I should also remark, that the intelligent engineer of the work estimates its capacity annually at 1,584,000 tons with a double track, and with a single track 693,000 tons. According to the principles which have governed this report, its double track capacity is 1,089,646 tons, and its single track capacity 272,411 tons per annum; but it is possible that rather better results may be obtained by the local adaptations which have already been alluded to.

In looking over the working of the Reading Rail Road for a series of years, it is found that about ¼ of all the work in each year is done in one month of that year, and that the true measure of the capacity of a rail road engaged in the Anthracite trade, is what it can do in 210 working days; or in other words, owing to the irregularity of the trade, all the work of a year could be done in that many days, were it possible so to concentrate it, and it is concentrated nearly in that proportion for some six months in each year. The number of loaded trains taken as the measure of capacity is in all cases 9,149, or one every 33 minutes for the full time of 210 days, of 24 hours each. We also find that the number of trains necessary to transport a given amount of coal over the main trunks leading to the seaboard, must have an additional number of $\frac{50}{1000}$ allowed for the accommodation of passengers, promiscuous freight, and road business, as their necessary attendants. It will thus be seen that we have allowed for a train passing on each track every 22 minutes, and one over the road every 11 minutes for the time above mentioned, as the ultimate capacity of all double track rail roads; I think all will admit that this is enough, and I may be allowed to express the opinion that it can only be effected by a perfect system and a good quality of rails. If it were possible to pass trains so quickly in opposite directions over single track roads, their capacity would be half that of the double track, but, as it is not possible to do so, it has been taken at one-fourth.

Thus far we have been considering the effect of those new rail road projects on the trade of New York, at which point about one-fourth of the coal reaching Port Richmond finds a market, the remaining three-fourths is destined to other ports by sea-going vessels, and for this latter portion very different figures present themselves.

It will have been observed that one of these routes, which has its outlet

by the Belvidere Delaware Rail Road, is not intended for the supply of sea-going vessels, but to work in connection with the Delaware and Raritan Canal, and, as I shall shortly show, it will draw its supply from a comparatively small coal-field. It is not, therefore (in my humble opinion), likely to become so great a thoroughfare for this mineral as its projection on paper would seem to indicate; the capacity of the canal I will not attempt to estimate.

It will also have been observed that the only new outlet for the supply of sea-going vessels, is by the New Jersey Central Rail Road, the ultimate capacity of which is 2,000,000 tons. The cost of transporting coal to Elizabethport by this route is—

| | |
|---|---|
| By one of its branches, | $1 00 per ton. |
| By the other branch, | 1 79 " |

Whilst the cost to Port Richmond by the Philadelphia and Reading Rail Road is 66¼ cts. per ton. In this most important branch of the trade the Reading, therefore, can scarcely be considered as having a rival, and I would most respectfully invite your attention for a few moments to the sources from whence those several avenues will derive their traffic.

I am indebted to Henry W. Poole, Esq., Mining Engineer of Pottsville, for the following area of the several coal-fields and their respective drainage, and also for the very accurate boundaries of the coal which have been placed upon the map:—

| NAME OF COAL-FIELD. | NATURAL DRAINAGE IN SQUARE MILES. | | | |
|---|---|---|---|---|
| | Lehigh River. | Schuylkill River. | Susquehanna River. | Total. |
| 1st, or Southern field, | 3 | 70 | 42 | 115 |
| 2d, or Middle field, | 17 | — | 104 | 121 |
| 3d, or Wyoming field, | — | — | 120 | 120 |
| Totals, | 20 | 70 | 266 | 356 |

If we again arrange these areas according to their artificial drainage, or the channels along which their resources will flow to market, we have the following:—

| NAME OF COAL-FIELD. | Eastward to New York. | ARTIFICIAL DRAINAGE. | | | |
|---|---|---|---|---|---|
| | | Lehigh. | Schuylkill. | Susquehanna. | Total. |
| 1st, or Southern field, | | 4 | 92 | 19 | 115 |
| 2d, or Middle field, | | 17 | 42 | 62 | 121 |
| 3d, or Wyoming field, | 60 | — | — | 60 | 120 |
| | 60 | 21 | 134 | 141 | 356 |

It will thus be seen that 134 square miles of coal basins must have their outlet along the valley of the Schuylkill, whilst the Lehigh can claim tribute from only 21, and the Wyoming basin will only furnish 60 square miles for *eastward* transit, and it is now looked upon as well established, that the quan-

tity of coal per square mile in those fields which are drained by the Schuylkill, is much greater than either of the others. When we consider this fact in connection with the low price at which it can be placed on board vessels by the Reading Rail Road, and the mountain range which separates the Wyoming basin from the seaboard, it is evident that no rival works can take from it the commanding position which it now holds in the anthracite trade. Badly advised rivalries may occasionally arise, tending to deprive it, as well as other works, of a portion of their legitimate revenue, but such occurrences can only be of short duration. The topography of the country is such as to forever debar the possibility of a work being constructed equal to it in capacity, either as to the extent or cheapness of coal transportation.

We occasionally see it gravely asserted that grades are of small importance on rail roads, but we have been reviewing an extended system, in which the capacity varies from 500,000 to 4,000,000 of tons per annum, and this variation is produced by grades. It is not the object of this report to draw unfavorable comparisons except just so far as is necessary to illustrate the subject. Yet we see the Pennsylvania Coal Company, with a rail road capable of transporting 500,000 tons, now engaged in projecting a new road for a capacity of 700,000 tons, and thus looking ultimately to having two rail roads (which from their peculiar character will, at certain points, divide themselves into four), the joint capacity of which will be 1,200,000 tons. We have also seen, that whilst adverse grades of 25 feet per mile decrease the capacity one-half, they also increase the cost of transporting from $\frac{60}{100}$ to $\frac{80}{100}$ of a cent per ton per mile. This seems small, and may be of no very serious import on roads of a small business, but on coal bearing roads it is applicable to large quantities. If we compare two roads, each 100 miles long, the one having grades of 25 feet per mile, and the other level, and the demands for transportation on each amount to 2,000,000 of tons per annum, the difference in favor of the level road is $600,000, or the interest on $10,000,000. But the level roads can do double the business of the others, and that with the same amount of motive power, so that, whilst the graded road is carrying its 2,000,000 of tons for net cost, the level road can, at the prices, realize on its 4,000,000 of tons a profit of $1,200,000, or the interest on $20,000,000.

This communication has been prolonged greatly beyond its intended limits, and yet I must ask your indulgence, whilst I call your attention to a few figures indicating the movements of coal. Since the year 1851, the production of anthracite has been increasing with a considerable degree of regularity at the rate of 10 per cent. per annum, until it has reached, in 1855, 6,635,790 tons, and will attain 10,000,000 of tons in 1860. Nearly nine-tenths of this coal passes eastward, and the remainder has a westward movement. The movement west has been increasing more rapidly than that east in the period stated, yet the increase in the eastward movement has been steady, and at a rate which indicates that it will demand means for the transit of 9,000,000 of tons in 1860.

In order to judge a little of the channels which will accommodate this movement, we will suppose that the two new avenues will together carry 300,000 tons in the year 1856, that they will increase in 1857 to 500,00 tons, and that they will conjointly swell up to a business of 1,300,000 tons in the year 1860, which is about what may be expected from them.

We will also suppose that the Reading will go on increasing at the rate of ten per cent. per annum up to that time and we have about the following as the tonnage in five years from date, viz:—

| | |
|---|---|
| New roads to the North, | 1,300,000 tons. |
| Reading, | 2,500,000 " |
| Schuylkill Navigation, | 1,500,000 " |
| Lehigh Navigation, | 1,500,000 " |
| Delaware and Hudson Canal, | 1,200,000 " |
| | 9,000,000 |

I may state, in conclusion, that the Belvidere Delaware Road expect to

Continued on page 488.

*Statement of the Cost of Transporting Coal on the Philadelphia and Reading Railroad, for five years, ending Nov. 30, 1855, including the Charges due to Transportation, Machinery, Roadway, and Renewal of Tracks.*

## TRANSPORTATION AND MACHINERY.

| Year. | Tons carried. | Tons carried 1 mile | Miles run by coal trains. | Charges due to running coal trains per mile. | | Charges due to the transportation of coal per ton. | | Charges to which 10 per cent must be added for grades of 25 feet per mile. | | Constant charges. | | Total charges. | Charges per mile run. | Charges per ton per mile. | Average weight of loaded trains. | Average weight of empty trains. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total. | Per mile run. | Total. | Per ton per mile | Total. | Per ton mile. | Total. | Per mile of road. | | | | | |
| | Tons. | Tons. | Miles. | $ | Cents. | $ | Cents. | | | $ | $ | $ | Cents. | Cents | Tons. | Tons. |
| 1851 | 1,650,270 | 143,852,630 | 852,099.80 | 475,168 23 | 55·77 | 229,006 59 | 0·160 | | | 59,898 18 | 695 19 | 763,563 23 | 89·617 | 0·5326 | 619 | 206 |
| 1852 | 1,650,912 | 143,042,268 | 857,080.72 | 441,457 54 | 51·51 | 236,194 95 | 0·165 | | | 63,396 03 | 667 32 | 741,048 52 | 86·469 | 0·5180 | 623 | 213 |
| 1853 | 1,582,248 | 134,984,356 | 752,858.06 | 456,524 93 | 58·04 | 229,200 38 | 0·170 | | | 67,121 00 | 706 53 | 752,846 31 | 99·164 | 0·5578 | 657 | 227 |
| 1854 | 1,987,854 | 166,282,209 | 923,452.92 | 535,555 79 | 63·41 | 346,469 89 | 0·208 | | | 75,928 06 | 799 24 | 1,007,953 74 | 109·151 | 0·6063 | 695 | 237 |
| 1855 | 2,212,783 | 190,782,102 | 993,921·35 | 569,336 75 | 57·29 | 316,978 16 | 0·166 | | | 99,391 81 | 1,046 22 | 965,706 22 | 99·172 | 0·5168 | 795 | 251 |
| Transportation | 9,084,067 | 778,343,562 | 4,409,327·73 | 2,526,083 24 | 286·01 | 1,357,850 40 | 0·869 | | | 365,299 58 | 3,844 50 | 4,251,118 22 | 480·772 | 2·7816 | 3399 | 1136 |
| Average | 1,816,813 | 155,668,712 | 881,865·54 | 505,607 65 | 57·20 | 271,570 06 | 0·1738 | | | 73,045 91 | 768 90 | 850,223 64 | 96·115 | ·5463 | 664·4 | 227·2 |

## ROADWAY AND RENEWAL OF TRACKS.

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1851 | 1,650,270 | 143,852,630 | 852,099·80 | 3,660 48 | 0·430 | 37,921 67 | 0·026 | 96,126 76 | 0·067 | 37,009 20 | 389 57 | 174.718 31 | 20·51 | 0·122 | 622 | 206 |
| 1852 | 1,650,912 | 143,042,268 | 857,080·72 | 6,702 61 | 0·785 | 39.191 51 | 0·027 | 98,508 41 | 0·069 | 42,268 44 | 444 87 | 186,265 97 | 21·73 | 0·130 | 623 | 213 |
| 1853 | 1,582,248 | 134,984,356 | 752,858·06 | 4,264 93 | 0·558 | 45,189 60 | 0·034 | 101,273 94 | 0·075 | 34,678 87 | 364 99 | 185,501 74 | 24·69 | 0·137 | 657 | 227 |
| 1854 | 1,987,854 | 166,282,209 | 923,452 92 | 9,659 96 | 1·049 | 67,197 90 | 0·040 | 132,017 63 | 0·079 | 45,392 74 | 477 81 | 254,298 23 | 27·55 | 0·153 | 695 | 237 |
| 1855 | 2,212,783 | 190,782,102 | 993,921 35 | 9,019 44 | 0·907 | 88,797 73 | 0·047 | 190,610 ·8 | 0·100 | 91,106 48 | 959 01 | 379,533 88 | 38 18 | 0·199 | 795 | 251 |
| Roadway | 9,084,067 | 778,343,562 | 4,409,327 73 | 33,037 42 | 3·679 | 278,298 01 | 0·174 | 618,536 97 | 0·390 | 250,445 73 | 2,636 25 | 1,180,318 18 | 131·66 | 0·741 | 3399 | 1136 |
| Average | 1,816,813 | 155.6 8,712 | 881,865·54 | 6,607 48 | ·736 | 55.659 60 | 0·0343 | 123,707 39 | 0·078 | 50,089 14 | 527 25 | 236,063 63 | 26 33 | 0 148 | 664·4 | 227 2 |
| Total | 9,084,067 | 778,343,562 | 4,409.327·73 | 2,561,075 66 | 289·69 | 1,636,148 41 | 1·043 | 618,536 97 | 0·390 | 615,675 31 | 6,480 75 | 5,431.436 35 | 612·23 | 3·473 | 3399 | 1136 |
| Average | 1,816,813 | 155,668,712 | 881,865·54 | 512,215 13 | 57 94 | 327,229 68 | 0·21 | 123,707 39 | 0·06 | 123,135 05 | 1,296 15 | 1,086,287 27 | 122·45 | ·6946 | 664·4 | 227·2 |

derive some advantage by a peculiar construction of coal wharves at Trenton, by which the cost of dumpage will be saved. Should their experience prove such an advantage, your unimproved grounds at Richmond are well suited for similar arrangements. The Scranton interests are also looking to an advantage from the cheap mining of coal in their district; a similar advantage can be obtained for the Schuylkill region by a better way of reaching the middle coal-field, which is believed to be available.

*Tabular Statement of the Effect of various Grades on the Load of Locomotive Engines of 42½ tons weight, including Tender, Fuel, &c.*

| Grade per mile. | Gross load, including engine, tender, and cars. | Gross load, exclusive of engine and tender. | Net load. | Ultimate capacity of a double track rail road. | Ultimate capacity of a single track railroad. |
|---|---|---|---|---|---|
| Level. | 767·5 | 725·0 | 437·2 | 4,000,000 | 1,000,000 |
| 22 feet. | 429·8 | 387·3 | 238·5 | 2,136,392 | 528,863 |
| 25 " | 383·7 | 341·2 | 205·7 | 1,881,351 | 470,498 |
| 50 " | 255·8 | 213·3 | 128·8 | 1,178,892 | 294,598 |
| 55 " | 239·8 | 197·3 | 119·1 | 1,089,646 | 272,411 |
| 75 " | 191·8 | 149·3 | 90·1 | 824,325 | 206,081 |
| 100 " | 153·5 | 111·0 | 67·0 | 612,986 | 153,246 |
| 125 " | 127·9 | 85·4 | 49·5 | 452,811 | 113,202 |
| 150 " | 109 6 | 67·1 | 38·9 | 355,845 | 88,961 |
| 175 " | 95·9 | 53·4 | 30·9 | 282,662 | 70,665 |
| 200 " | 85 3 | 42·8 | 24·7 | 225,946 | 56,486 |
| 225 " | 76·7 | 34·2 | 19·7 | 180,207 | 45,052 |
| 250 " | 69·7 | 27·2 | 15·7 | 143,615 | 35,904 |
| 275 " | 63·9 | 21·4 | 12·4 | 113,428 | 28,357 |
| 300 " | 59·0 | 16·5 | 9·5 | 86,899 | 21,725 |

LACKAWANNA VALLEY COAL REGION.

An intelligent correspondent of the Philadelphia North American furnishes us with some valuable facts relative to present operations in the Lackawanna Valley:

The Delaware and Hudson Canal Co., by its age and the magnitude of its works, holds a pre-eminence over all the other coal companies in the valley. It not only owns a canal, as its name indicates, but also large quantities of coal lands, and works numerous mines. It has tracks for the transportation of coal from Archbald and Carbondale to the canal, and numerous accessory works at the places named. The capital is $7,500,000, and the net profits last year were over 18 per cent. The number of tons transported by this company on the canal during the year 1855 was 565,376.

The Pennsylvania Coal Co. operates at Pittston, Port Griffith, and Dunmore. It has a capital, I think, of about $3,000,000, and made last year 11 per cent profits. This company also uses the Delaware and Hudson Canal for shipping its coal to New York, the mines of the company being connected with the canal at Hawley by railroads. The amount of shipment during the year preceding the last report was 496,000 tons.

The Baltimore Coal Company is located at Wilkesbarre. It is engaged, I am informed, entirely in mining, and does not perform any transportation. The coal is sold and delivered at the mines, or on the Susquehanna river, to be transported by boatmen to markets in the towns upon the river and canals.

The Lackawanna Railroad and Coal Company has created a town called Jessup, between Carbondale and Scranton. It owns 2000 acres of coal land, and the coal in 330 acres more. The mines are connected by railroad with the road of the Delaware, Lackawanna and Western Railroad Company, at Greenville, and a contract has been made by which the latter company has

engaged to deliver for the former at Elizabethtown, N. J., 100,000 tons of coal during the year 1857, 150,000 tons per annum thereafter, until a double track is laid, and 300,000 per annum afterwards; the time for commencing the delivery of the latter amount not to be delayed beyond January 1, 1860. The capital of this company is $2,000,000, and it is of recent origin.

The Lackawanna Iron and Coal Company is established at Scranton. It not only mines coal but manufactures iron, the ore for the latter being procured partly in the vicinity, and partly brought from New York State. The furnaces and rolling mill at Scranton, are alone sights worthy of being seen. They are constructed on a large scale, and in the most scientific manner. A splendid steam engine of 2000 horse power, said to be the largest in the country, is employed at the furnaces merely in blowing air, yet even for this single purpose it is insufficient. It is a wonderful giant.

The Delaware, Lackawanna and Western Railroad Company is also a Coal Company. But I have already alluded several times to this very superior road —which is destined to have an immense coal business—in former letters.

The various companies which I have mentioned have been for some years in existence, and are operating under special charters. In addition to them are many others, recently established, and operating under the general mining law. They are named in the following table, prepared by Mr. Lewis Jones, of Scranton, to whose kindness I am indebted for much information, and originally published in the *Spirit of the Valley:*

| *Names of Cos.* | *Cap. Stock* | *Names of Cos* | *Cap. Stock.* |
|---|---|---|---|
| N. Penn. Coal Co. | $500,000 | Hollenback | $ 60,000 |
| Pittston | 500,000 | Dundee | 500,000 |
| Northampton | 400,000 | Wyoming Plains | 500,000 |
| West Pittston | 500,000 | William Penn | 500,000 |
| Erie and Susquehanna | 500,000 | N. Y., and Wyoming | 500,400 |
| Scranton | 150,000 | National Anthracite | 500,000 |
| Dock | 300,000 | N. Y. Pa. and Lackawanna | 300,000 |
| North Branch | 250,000 | East Scranton | 250,000 |
| Geneva | 50,000 | Rose Hill | 250,000 |
| New York and Scranton | 350,000 | Luzerne of Penn. | 225,000 |
| Mill Creek | 509,500 | Carbondale | 50,000 |
| Hano er | 400,000 | Van Stork | 65,000 |
| Empire | 500,000 | Mammoth Vein | 200,000 |
| Penn. Anthracite | 500,000 | Scranton Anthracite | 500,000 |
| Hyde Park | 500,000 | Lack., Lanesboro' and New York | 125,000 |
| Hartford | 500,000 | Howard | 150,000 |
| Maryland Anthracite | 300,000 | Kimberton | 500,000 |
| Springbrook | 500,000 | Wyandotte | 300,000 |
| N. Y. and Penn | 500,000 | Philad. and Pittston | 100,000 |
| N. Y. and Pittston | 500,000 | Ravine | 200,000 |
| Luzerne Co. Prov. | 225,000 | Kingston | 250,000 |
| Fellows' | 250,000 | Junction | 250,000 |
| Luzerne Anthracite | 300,000 | | |

About one-half of the above mentioned capital is contributed, I am told, by Philadelphia. Until recently, New York has furnished a majority of the capital and men engaged in the improvement of this valley, but the attention of Philadelphians is now attracted hither.

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### COAL BURNING LOCOMOTIVES.

In continuation of this subject, we present the following further statements:—

In England—next to Mr. MacConnell—the most successful engineer of coal-burning engines has been Mr. Joseph Beattie, of the London and South-western line. In the case of his engine, the weight is not very materially increased by any serious enlargement of fire-box, and although running heavy express trains with so small a consumption of fuel, as 17 lbs. per mile, yet the fact that two-thirds of this is coke fuel, the remaining one-third only being raw coal, and *that* even this is only effected by a complicated arrangement of double fire-

boxes, has prevented the adoption of the engine, and indeed while ordinary engines can run with heavy trains, with an average consumption of coke of 22 lbs. per mile, (see accompanying half-yearly report of London and Brighton road), it is not likely that heavier, more complicated, and more expensive engines, in first cost and repairs, will supplant them.

The following is an account of the performance of Mr. Beatty's engine—described in a paper, read before the Institution of Mechanical Engineers:—

The economy of fuel in working locomotive engines is a subject of great importance to railway companies, and has attracted considerable attention for many years; but at no period since the introduction of railways has this subject been of such moment as at the present, by reason of the great demand for coal, and the consequent increase of price.

The writer having been connected with one of the metropolitan railways for many years, and coal being so very expensive in the South, was led to the consideration of economy in fuel and the production of steam at the lowest possible cost, the accomplishment of which appeared to be in the employment of coal to be used in a separate and distinct fire-box, but in connection with the coke fire-box of the locomotive engine; and this idea was strengthened by the observation of the working of the coke ovens in the manufacturing of coke, where he often lamented to see the great amount of flame and combustible gases pass off into the flues and chimney without producing any useful effect; and when it is remembered that 1 1-2 ton of good coking coal is required to produce one ton of coke, some estimate may be formed of the quantity of combustible gases that is thrown off.

Being anxious to secure the advantages which appeared to be got by the use of coal in connection with coke in the generation of steam, the writer considered the proper mode was to use coke and coal in separate furnaces, so arranged that the flame and combustible gases thrown off the coal fire would enter into and pass over that of the coke fire, and entering by short tubes into a combustible chamber, situated partly central between two sets of tubes in the cylindrical portion of the boiler, and where complete combustion would be effected.

A new engine on this principle has not yet been completed, but it has been applied in part to six engines, with the ordinary boiler, on the London and South-western Railway, and the results of working have been found most satisfactory. One of them, the "Britannia Engine," with 15-inch cylinders, 21 inch stroke, and 7 feet driving wheels, has been working since August, 1853, and run 13,600 miles between Southampton and London, a distance of 78 3-4 miles, taking the regular running of passenger trains; the average consumption has been 17 lbs. per mile, one-third of which was coal, but charged in weight as coke. An experimental trip was made with this engine by Mr. Edward Woods, in October last, with one of the passenger trains to Southampton and back to London; and another experimental trip was made by Mr. W. P. Marshall, Secretary of the Institution, of the same engine, with the 10.15 A. M. mail train from London to Southampton, on the 17th January, returning with the 3 P. M. train to London; the particulars of these experiments are appended, and the general results are as follows:—

EXPERIMENTS *with the "Britannia" Engine and Passenger Trains, from London to Southampton and back.*

| | | Oct. 26, 1853. | Jan. 17, 1854. |
|---|---|---|---|
| Length of double trip with train | miles | 157¼ | 157¼ |
| Length of double trip with engine | miles | 161¼ | 161¼ |
| Down trip, average train | carriages | 12.8 | 11.2 |
| Down trip, average speed running per hour | miles | 31.4 | 28.3 |
| Down trip, number of stoppages | No. | 8 | 8 |
| Up trip, average train | carriages | 18.5 | 19.3 |
| Up trip, average speed running | miles per hour | 29.4 | 27.5 |
| Up trip, number of stoppages | No. | 7 | 7 |
| Total consumption of coke | cwt. | 16 | 18 |
| Total consumption of coal | cwt. | 8 | 8¼ |
| Total consumption, per mile of train | lb. per mile | 17.1 | 18.4 |

| | | | |
|---|---|---|---|
| Total consumption per mile of engine | lb. per mile | 16.7 | 18.2 |
| Water evaporated per lb. of fuel | lb. | 6.8 | 8.1 |
| Average pressure of steam, down trip | lb. per mile | ... | 105 |
| Average pressure of steam, up trip | lb. per mile | ... | 100 |
| Greatest pressure during trips | lb. per mile | ... | 128 |
| Least pressure during trips (omitting last ten miles) | lb. per mile | ... | 82 |
| Average pressure in up trip over 17 miles, rising 1 in 250, between Bishopstoke and Basingstoke | lb. per mile | ... | 122 |

The action of the coal and coke fire-boxes is as follows:—The coal fire-box is attached to the back of the fire-box of the ordinary locomotive engine, as shown in the plan, and placed partly below the foot plate, the water space of which is in connection with that of the coke fire-box, by two branch pipes at bottom and two at top. The flames and combustible gases thrown off the coal fire, pass into the coke fire, through tubes inserted into the intervening water space; and to promote the combustion of the gases, by giving more time for better admixture, a curved fire-tile bridge, forming a sort of combustion chamber, is placed within the coke fire-box, fronting the tubes leading from the coal fire-box, thereby checking the velocity of the flame in its passage over the surface of the coke fire. The coal fire-box and the coke fire-box are provided with separate ash-boxes and close-fitting dampers, whereby the draught to each can be regulated with the greatest nicety, and independent of each other. The damper of the coke fire-box is generally kept nearly closed, and is only opened 1-2 inch, with trains from 20 to 24 carriages;* but the damper of the coal fire-box is generally kept quite open, to admit the full draught of the blast, by which means the coal fire being excited to the utmost, the gases and flame pass into the coke fire, nd with them the air in a heated state; the high temperature of the coke fire is maintained, and more perfect combustion is the result. The combustion of the smoke is completely effected, the smoke being scarcely perceptible. An important practical advantage is gained from the circumstances of *the ordinary coke fire door being kept almost constantly closed, the door being opened only three times to put on coke during the whole trip of* 78 3-4 *miles*, thus preventing the frequent rush of cold air cooling the fire-box and tubes, and causing a liability of leakage; in the present case, all the air entering at the coal fire door becomes highly heated before coming in contact with the main fire-box and tubes.

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### BOARDMAN'S COAL BURNING LOCOMOTIVE.

The fire-box is of the usual kind. The body or waist of the boiler has flat sides and flat bottom. A large flue of a ⊂ shape, extends from the fire-box to the forward end of the boiler. The flat bottom of this flue is the tube sheet. The tubes are vertical, the fire passing through them and the water being around them, in the last respects like ordinary boiler tubes. The lower tube sheet is really the bottom of the boiler, just as the common front tube sheet makes the end of the common boiler. An ash pan is made under the bottom tube sheet, and extended forward and up in front of the end of the boiler, into a suitable smoke box, from whence the escaping products of combustion are discharged through a straight open chimney. The boiler burns Cumberland coal.

The large flue forms a combustible chamber, for the complete burning of whatever gas, sparks, etc., may arise from the coal. It affords a considerable extent of very effective heating surface. So, too, from forming so large a reservoir of air, the draught is equalized in it, so as to obviate the usual impulsive, cutting action of the exhaust on the coal. It has been observed as a singular fact that an anthracite coal burner, built in Paterson, with a combustion chamber projecting 3 feet from the fire-box into the boiler, did not throw coal or sparks from an open chimney, under the ordinary exhaust. This result

* An English carriage loaded weighs about 10 tons gross.

was attributed to the intervention of so large a body of air between the exhaust and the fire-box, which acted to equalize the draught on the fire, just as the lower air chamber of a pump acts to equalize the suction in the feed pipe. The tubes are removed from the direct action of the fire, and thereby protected from being rapidly burned out.

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### COAL BURNERS AND LIGHT CARS.

Mr. D. H. Dotterer, Superintendent of the Northern Division of the Delaware, Lackawanna and Western Railroad, in his report to the Directors, gives some interesting items as to the economy of heavy cars and light rails, and some other matters. We extract a few passages:

"The coal-burners have had a severe trial on this road during the past year, and have shown, conclusively, that their advantageous employment on this road is no longer doubtful.

Important improvements have been made in the construction of four-wheeled coal cars, diminishing their dead weight nearly one-third, yet leaving their strength the same. Some reduction is also effected in their first cost. The eight-wheeled side-dump coal cars, have also been improved, rendering them capable of being dumped with ease, and of discharging the coal entirely clear from the track upon level ground, or where trestling cannot be constructed for bottom dumps. The couplings and bumpers of these cars are so constructed as to admit of their being run, with safety, in the regular freight trains, and are well adapted for carrying coal to remote points on connecting roads, and for bringing back freight in return. The four-wheeled coal cars are not built to admit of this, nor to run with the speed usual in such trains, especially on curves.

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### THE FEATHER RIVER COAL FIELD.

The coal field is situated about thirty-three miles from Marysville, and distant four miles from Oroville, on the Feather River. The discovery was made nearly two years ago, since which time preparations have been made by tunnelling, draining and otherwise, to render the working of the mine easy and practicable. The deposit, which is several feet thick, has been struck at the base of the mountain, so that it can be worked at all seasons.

A tunnel 900 feet in length has been opened for the purpose of drainage. The tunnel passes through the coal to the distance of one hundred and fifty feet. The field has been prospected to the distance of several miles, without discovering any appearance of its diminution. Mr. J. S. Wardner, one of the company, is now in this city, having with him a sample of the coal; we examined it yesterday and witnessed its use as fuel in a grate at the Orleans Hotel. The coal is of a dull grayish black color, moderately hard, but easily frangible; it is extracted in rectangular masses, often breaks trapezoidal; it kindles very readily, and burns freely, with a bright, white flame, has no disagreeable odor, and produces very little smoke. Indeed, it nearly resembles the Cannel coal of the Woodhall Coalfield, near Glasgow, with a specific gravity, varying from 1.22 to 1.28. Like the Cannel coal, it scarcely soils the hand with carbonaceous matter; it burns almost entirely free from slate or earthy impurity, and leaves a much smaller proportion of ashes than any coal we have ever seen burned: the ash is very light and white. The existence of pit coal in California has long been a subject of anxious speculation, and search for it has been repeatedly made. If the coal field near Oroville is of the extent we are informed it is, and will yield an abundance of so excellent an article as that exhibited to us yesterday by Mr. Wardner, it will be of immense benefit to the State. The present price of coal, we are informed, varies from $80 to $85 per ton. The California coal can be dug out, carted to the Feather River, loaded in flat boats, and brought down to market for less than half that sum, and still leave a handsome profit.—*California Tribune.*

# IRON AND ZINC.

## MANUFACTURE OF PIG IRON.

MR. EDITOR:—In looking over your very valuable Magazine for April, in the article Western Railroad Iron Works, the writer tries to show that they can make pig iron for the small sum of $10 per ton, without saying any thing farther. I think that the writer will have some trouble to convince practical iron manufacturers (no matter how convenient the locations) that pig iron can be made for $10 per ton. Following in the same article, he states that the cost of producing pig iron at the Lehigh Crane Iron Works, to be $15.52 per ton. Permit me here to state, that about three years since, a gentleman well acquainted with the manufacture of iron, and who intended at the time to establish furnaces on the line of the Morris Canal, in New Jersey, in order to ascertain the competition he would have to contend with, made a very careful inquiry at those works of the actual *cost* of producing their pig iron, and which I have received from himself, which is as follows:

| | | |
|---|---|---|
| tons of Pennsylvania ore, | $2 63 | $5.26 |
| ton of Jersey ore, | 4.00 | 2.00 |
| tons of coal, | 2.71 | 5.42 |
| Lime-stone, | | 75 |
| Labor, | | 2.92 |
| Incidentals, expenses, repairs, &c., | | 75 |
| Interest on coal and ore for winter use, | | 20 |
| General superintendence, &c., | | 80 |
| | | $17.60 |

Without saying any thing for loss of interest on the iron before sold, which is not less than 2 per cent., or about 32 cents per ton, we find that the actual cost at that time of manufacturing pig iron at the Lehigh Crane Works was not less than $17.60. Since that time materials of all kinds, except lime-stone, have increased not less than from 25 to 30 per cent.; labor not less than 12 per cent., so that pig iron cannot be manufactured at those furnaces at present for less than $20, instead of $15.52. More than this, it is impossible (no matter how convenient the materials, or how well located the works may be) to make pig iron for $10 per ton. The Boonton Furnace has and can manufacture pig iron and deliver the same in the New York market for less than it can be had from the Crane Works, although they have but a 14 feet furnace. At the time that this estimate was made, the Crane Company bought iron ore in New Jersey, for $2 to $2.50 per ton, while they cannot now purchase the same kind of ores for less than from $3 to $3.50, but the ores they get from New Jersey they mine themselves, of the cost of which I shall speak farther hereafter, but I may safely state that they do not get it at their works for less than $5.75 per ton.

PRACTICE.

DOVER, NEW JERSEY, April 19, 1856.

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## THE MONTOUR IRON WORKS, DANVILLE, MONTOUR COUNTY, PA.

Those extensive works—Mills, Furnaces, &c., are truly interesting objects, whether viewed in a business sense or as a scene, particularly at night, when all their fires glow with the most intense brilliancy, and the hissing masses of liquid iron burn, scintillate and sparkle like a thousand stars, whilst the flaming furnaces cast far and wide their lurid glare—it is truly grand and animating. But when we observe the dusky forms, flitting backwards and forwards, tugging at the glowing masses of iron, like huge serpents writhing and twisting in agony, thoughts of Pandemonium, Vulcan, Cyclops, &c., &c., become associated with the scene.

The Montour Rolling Mill is the largest of its kind in America. The building stands on a piece of ground, which is nearly 200 yards long by 100 yards wide, whilst the furnaces, yards, offices, houses, &c., belonging to the Company, occupy nearly one half of Danville.

Messrs. Chambers & Biddles erected the first Anthracite Furnace here about 1842, but an old Charcoal Furnace, still standing, was erected many years before by Burd Patterson, if we mistake not. In 1844–5 another furnace was added by the Montour Company, and since, though several changes have taken place, and many difficulties occurred, the premises have been gradually extended to its present extent and capacity. Messrs. Haywood & Snyder, our Schuylkill county friends, had them in hands at one time, and their old machine shops here, which are extensive, are still in operation and made use of by the Montour Company. They also erected most of the machinery now in use in the mills.

A force of 1000 hands were employed by this company at their mills, furnaces, mines and quarries during the winter, whose wages ranged from 90 cents to $3 per day—averaging nearly $2 per day to each, consequently one would think there would be no reason for a "strike" of the kind which has recently occurred. One hundred tons of T rails, from 60 to 70 lbs. to the yard, are turned out daily from the Rolling Mills. Their average composition is two thirds puddled iron, and one third reheated iron, though they are now making some for the Reading Railroad, which are composed of reheated iron entirely. Their rails are solid, and have the appearance of great strength, though we have seen smoother rails made at other mills, which we would observe, however, is not a criterion by which to judge of their value. They make nothing but large sized rails at the Montour Works.

Seventy-two puddling furnaces are made use of here, and eleven reheating furnaces, which, with two rail mills, and all the accompanying machinery, with men and boys to keep them in full operation, present a scene of rare activity and bustle.

Five engines are made use of in the mill, for the purpose of driving the fans, puddle trams, rolls, &c., &c. 1 of 90, 1 of 60, 1 of 40, and 2 of 30 horse power—each averaging 250 horse power in the mill. At the furnaces, three 90 horse engines are employed and one 30, besides those employed at the mines.

They make use of the Pittston coal generally, for their puddling furnaces, or the lower benches of the Baltimore vein, in the vicinity of Wilkesbarre—the purer benches being too hard and brittle to answer their purpose. But the hard and denser varieties are prepared for the furnaces.

I think that Mr. W. S. Ridgeway, the gentlemanly manager of the mill, who very kindly escorted me through, and blandly answered all my impertinent questions, told me that they used something over 100,000 tons of coal annually.

The company mine all their own ore, and quarry their own limestone from their lands on the Montour ridge, of which they have over 12,000 acres. Their openings are numerous, and on the three veins of ore which here exist, yet on but two of them have they made extensive improvements, by which the ore is brought up from below the water level by steam power.

Messrs. J. P. & S. Groves, of the Columbia Furnace, are the agents of the Montour Iron Co.

S. H. D.

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### THE IRON TRADE AND RESOURCES OF THE UNITED STATES.

The production of Iron in the United States, for the year ending June 30, 1850, as estimated by the last Census, was as follows:

| | Tons. | Value. |
|---|---|---|
| Pig Iron, | 564,755 | $12,748,777 |
| Castings, | 322,745 | 25,108,155 |
| Wrought Iron, | 278,044 | 16,747,074 |
| Total, | 1,165,544 | $54,604,006 |

The number of establishments operated in this production was 2190, employing about $50,000,000 of capital, and a little more than 57,000 hands.

The value of the product of some of the largest producing States was as follows:

| | Pig. | Cast. | Wrought. |
|---|---|---|---|
| Massachusetts, | $295,123 | $2,285,635 | $428,990 |
| Connecticut, | 415,600 | 981,400 | 667,560 |
| New York, | 597,920 | 5,921,980 | 1,423,968 |
| Pennsylvania, | 6,071,518 | 5,254,881 | 3,902,907 |
| Ohio, | 1,255,850 | 3,069,350 | 1,076,192 |
| Maryland, | 1,056,400 | 685,000 | 771,451 |
| Virginia, | 621,924 | 674,416 | 1,254,995 |
| Tennessee, | 676,100 | 264,325 | 670,618 |
| Missouri, | 314,600 | 386,495 | 63,700 |
| Kentucky, | 604,087 | 744,316 | 299,700 |

The amount of capital employed in the above States, in 1850, was the largest in Pennsylvania, being between nineteen and twenty millions of dollars. In New York it was about $6,300,000; Connecticut $1,309,000; Massachusetts $1,578,350; Ohio $4,200,000; Missouri $850,000, &c.

The amount of 1,165,544 tons, valued at $54,604,006, being the total production of iron in a single year within the limits of the Union, is a large yield in this one article of our manufactures. Fifty-four millions of dollars is enough to pay Uncle Sam's yearly expenses, were they brought within the limits which they should be and would be if all the drones and treasury peculators could be turned out of office and faithful men put in their places. But this yield is only as a grain of sand on the sea-shore, when the whole iron resources of the Union are considered. The recent geological survey of Missouri, now one of the smallest iron producing States, sets forth that there is ore enough, of the very best quality, within a few miles of Pilot, Knob and Iron mountains, above the surface of the valleys, to furnish one hundred millions tons per annum of manufactured iron for the next two hundred years! And to work this inexhaustible quantity of ore, that State alone can furnish one hundred million tons of excellent coal per annum, for the next 1300 years! Add to this the immense iron and coal resources of Pennsylvania, Maryland, Virginia, Kentucky, Tennessee, Ohio and other Alleghany States, and to that product the resources of those which will soon border on the Rocky Mountains, and we have a good prospect that iron and coal will not fail us until some time after our gold-mines have given out and our forests disappeared.

So much for the production of iron in the United States and our resources for increasing it. The great necessity for so doing is made apparent by turning our attention to the large amount which has been imported during the last fifteen years. We have shown that the census of 1850 estimated the yield for that year (ending June 30) at something over $54,000,000 in value. From interesting statistical tables published in connection with the last report of the Secretary of the Treasury, it appears that we imported during that year $16,538,145 worth, which in 1854 had swollen to $29,341,775, or more than half the whole amount produced in 1850 with all our great resources. The value imported in 1855 seems to have decreased from six to seven millions, *being* $22,980,728. This may result from a decreased demand caused by the *completion of* railroad projects. But with the settlement of the great West,

the demand is destined soon again to be greater than ever. With a population of little less than twenty millions in 1850 it has been estimated that the completion of another half century will usher in the year 1900 upon not less than one hundred millions of souls inhabiting Uncle Sam's domicil embraced between the Atlantic and Pacific! This vast people will have occasion for a very large supply of iron which they cannot import.

We compile the annexed interesting table of the value of iron imported and exported, from 1840 to 1855 inclusive, from the Treasury statistics already referred to. It embraces iron and manufactures of iron.

| | Foreign imported. | Foreign exported. | Domestic exported. |
|---|---|---|---|
| 1840 | $6,750,099 | $156,115 | $1,104,455 |
| 1841 | 3,914,425 | 134,816 | 1,045,264 |
| 1842 | 6,988,965 | 177,381 | 1,109,523 |
| 1843 | 1,948,353 | 50,802 | 582,698 |
| 1844 | 5,227,484 | 107,956 | 716,883 |
| 1845 | 3,294,878 | 91,966 | 845,017 |
| 1846 | 7,385,389 | 122,587 | 1,151,783 |
| 1847 | 3,781,259 | 53,196 | 1,167,484 |
| 1848 | 12,596,854 | 98,295 | 1,959,698 |
| 1849 | 13,881,838 | 109,489 | 1,496,172 |
| 1850 | 16,393,145 | 100,746 | 1,911,320 |
| 1851 | 17,906 700 | 100,290 | 2,355,696 |
| 1852 | 18,957,998 | 134,987 | 2,806 819 |
| 1853 | 27,265,425 | 262,943 | 2,499,652 |
| 1854 | 29,341,775 | 795,879 | 4,210,850 |
| 1855 | 22,880,729 | 1,565,523 | 3,758,472 |

STATEMENT SHOWING THE IMPORTS OF IRON FOR FIVE YEARS ENDING JUNE 30, 1855.

| | 1851 | 1852 | 1853 | 1854 | 1855 |
|---|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. | Tons. |
| Pig iron, | 67,250 | 91,734 | 114,227 | 160,488 | 93,956 |
| Sheet, | 14,967 | 13,570 | 19,107 | 16,592 | 14,576 |
| Hoop, | 6,518 | 5,999 | 6,033 | 5,818 | 7,042 |
| Nail and spike rods, | 599 | 504 | 1,977 | 3,993 | } 6,382 |
| Brazier and other rods, | 1,402 | 1,978 | 1,633 | 893 | |
| Band and scroll, | 399 | 679 | 652 | 680 | inc. in br. |
| Old and scrap, | 8,395 | 7,687 | 9,990 | 18,604 | 15,299 |
| Railroad iron, | 188,626 | 245,626 | 298,995 | 282,666 | 127,517 |
| Bars manufactured by rolling, | 65,678 | 45,763 | 8[illegible],858 | 45,752 | 116,911 |
| Bars manufactured otherwise, | 20,198 | 44,903 | 17,595 | 18,620 | in. above. |
| Total tons, | 374,027 | 457,190 | 553,466 | 548,480 | 386,652 |
| | A | B | C | D | E |
| STEEL. | | | | | |
| Cast, shear, &c., | 6,358 | 7,940 | 12,988 | 10,075 | 9,075 |
| Other kinds, | 1,705 | 2,336 | 3,329 | 3,589 | 4,314 |
| Total tons, | 8,063 | 9,276 | 16,267 | 13,664 | 13,389 |
| | F | G | H | K | L |
| Manufactures of iron, and iron and steel | 11,982 | 11,564 | 13,298 | 15,129 | 13,383 |
| | M | N | O | P | Q |

These figures show an increase in the iron importations for the past fifteen years, from six and a half up to twenty-nine millions. There is a marked variation between the years 1842 and 1843. With this exception,

the importations seem to have uniformly increased until last year (1855), when they fell off more than $2,000,000 from those of 1854, while there was a large ratio of increase in the export of domestic iron. This would seem to augur favorably for the increasing prosperity of our iron manufactures.

SUMMARY OF IMPORTS OF IRON, STEEL, AND MANUFACTURES OF IRON AND STEEL BY YEARS.

| | | Iron. | | | Steel. | | | Manufactures of iron and steel wares. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tons. | Value. | | Tons. | Value. | | Tons. | Value. |
| 1851 | A | 374,027 | $10,304,100 | F | 8,063 | $1,570,063 | M | 11,932 | $7,159,486 |
| 1852 | B | 457,190 | 11,919,625 | G | 9,276 | 1,703,199 | N | 11,564 | 6,938,370 |
| 1853 | C | 556,466 | 17,276,326 | H | 16,267 | 2,970,313 | O | 13,296 | 7,979,119 |
| 1854 | D | 548,490 | 17,262,598 | K | 13,632 | 2,477,709 | P | 15,182 | 9,979,182 |
| 1855 | E | 396,658 | 13,950,941 | L | 14,383 | 2,566,187 | Q | 13,333 | 8,629,787 |
| Total, | | 2,334,815 | $70,613,585 | | 60,621 | $11,314,821 | | *65,309 | $39,185,944 |

* The number of tons is estimated by dividing $600 into the value.

GRAND RESULT FOR FIVE YEARS ENDING JUNE 30, 1855.

| | Tons. | Value. | Price. |
|---|---|---|---|
| Iron . . . | 2,334,814 | $70,613,585 | $30 38 |
| Manufactures of iron, and iron and steel, | *65,309 | 39,185,944 | *600 00 |
| Steel, . . . | 60,621 | 11,314,821 | 186 64 |
| Total tons, . | 2,450,745 | 121,114,350 | |

* Price per ton, partly estimated, and the quantity ascertained by dividing the value by $600.

TABLE OF PRICES PER TON OF IMPORTED IRON AND STEEL FOR FIVE YEARS.

| Years. | Pig iron. | Sheet iron. | Hoop iron. | Nail and spike rods. | Brazier and other rods. | Band and scroll iron. | Old and scrap iron | Railroad iron. | Bars manufactured by rolling. | Bars manufactured otherwise. | Cast, shear, German, &c., steel. | Other kinds of steel. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ |
| 1851 | 11 71 | 47 98 | 37 45 | 24 94 | *17 24 | 61 28 | 20 00 | 25 98 | 38 41 | 44 52 | 199 14 | 195 85 |
| 1852 | 11 97 | 56 98 | 38 59 | 36 37 | 33 62 | 61 05 | 13 31 | 25 36 | 51 12 | 29 48 | 191 52 | 160 90 |
| 1853 | 13 38 | 58 74 | 43 61 | 47 27 | 37 45 | 54 28 | 14 51 | 34 87 | 56 33 | 35 68 | 181 25 | 188 19 |
| 1854 | 18 03 | 69 58 | 57 25 | 49 44 | 53 86 | 63 84 | 18 57 | 42 49 | 56 77 | 48 45 | 183 05 | 178 15 |
| 1855 | 20 01 | 69 30 | 60 82 | Averaged | 53 86 | † | 16 29 | 31 32 | 50 78 | † | 180 43 | 198 36 |
| Average | 15 02 | 60 51 | 47 54 | 42 38 | 39 21 | 60 11 | 16 54 | 32 00 | 50 68 | 39 53 | 187 05 | 184 29 |

* Probably erroneous for this year; correct value about $32, which would correct the average to $40 12. † Merged with bars. *Boston Railroad Times.*

RAILROAD IRON.

The total consumption of railroad iron in the United States, for the last five years amounted to 1,643,629 tons, of which 1,143,629 were imported, while 500.000 tons represented the produce of our domestic establishments. At first sight, the comparison seems to argue unfavorably for us, but inquiring into the subject more minutely, we shall soon discover that, just at this moment, a combination of circumstances exists which, if properly understood and turned to account, cannot fail to secure the brightest prospects and ultimate success to our home industry. In 1851 we imported 188,625 tons of rails; in 1852, when in this country, as well as in Europe, numerous railroads were projected, this importation rose to 245,625, and in 1855 even to 298,995. In 1854, when the effects of the war began to exercise an influence, it decreased to 282,663, while our domestic productions attained the height of 121,183 tons. In 1855, foreign importations sunk down to 127,516, and for the first time our home establishments furnished over one-half of the annual supply, namely, 735,300 tons.

Considering that ten years ago no rails were manufactured in the United States, this result is a most encouraging one, and not the less so for having been achieved without any other legislative assistance than a protective duty no higher than that levied upon the importation of the raw material. We have on a former occasion pointed out the inefficiency of our tariff, which taxes the importation of railroad iron at the same rate as pig iron, though the former represents double and treble the amount of foreign labor. In the short period of ten years, we have erected in eight different States of this Union, eighteen mills, in which a capital of twelve millions of dollars is invested, and have finally succeeded by dint of perseverance and individual exertions and sacrifices of various kinds, in supplying the country with more than half of its annual consumption of railroad iron. It would, however, be an egregious and fatal mistake to suppose that the victory is a complete one. Such as it is, it is as much the consequence of outward circumstances over which we have exercised no control, as the result of our own labors. The emigration which had taken place previous to 1852 and 1853, from Great Britain to Australia, California and the United States, and the drain of men and money subsequently occasioned by the war against Russia, blunted the formidable weapons—abundance of capital and cheapness of labor—which British manufacturers wielded over their competitors abroad, and hence our success. The advantage is of a negative and temporary nature, and the important question arises, whether it is possible to render it, so far as we are concerned, positive and permanent. One thing is very certain. If this emigration of a few years, and a war of no more than two, could affect the industry of Great Britain in such a manner as to permit our manufacturers to gain a march upon it and to achieve a very significant triumph, the idea of its unapproachable superiority, so mischievous and discouraging in its tendency, is at once and for ever exploded. The *ad captandum* argument that it is impracticable to resist the causes, social and financial, which lead to the backwardness of American industry, an argument heretofore used with fatal effect to the detriment and ruin of our national interests, has received its *quietus*. The war has solved the great problem. It has proved beyond cavil or contradiction that its effects were as trying to British industry as its difficulties were to British military skill and generalship. The war has cost Great Britain twenty millions of pounds sterling per annum over and above the ordinary expenses of the army and navy and civil government, and this and previous emigration have enabled our iron masters to raise the production of pig iron to 1,000,000 tons per annum, or 500,000 tons more than it was in 1852; and it has enabled our rail manufacturers to produce over one-half the annual consumption of railroad iron, while previous to the Eastern contest they could not furnish even one-third. We have to deal here with causes and effects, and it behooves us to analyze them, and to profit by the lesson they inculcate. The balance of trade in 1855 was over fifty millions of dollars against us. It is in our power to

equalize the difference, if not entirely, at least to such an extent as to make the consequences felt on the other side of the Atlantic and to counterpoise that financial preponderance which now weighs down our home industry. In proportion as our domestic manufactures gain upon those of Great Britain, in that proportion will the other cause of our recent success, the emigration, gain in magnitude, and to this extent the result will prove a merciful dispensation for those immediately concerned. No creation of the human brain, no institution, social or political, on the globe, has ever had such brutalizing effects, has ever ground the masses down to such abject misery and degradation, as the cheap-labor system of British industry—a system upheld by reducing foreign nations to be producers of raw material, and the British people to mere machines for its conversion—both at starving wages. The British system of industry, which draws its materials from the most distant regions of the globe, thus enhancing the raw material by transportation; then carrying it back when changed into manufactures, and adding again to its price without increasing its value beyond that obtained by conversion, is in reality a most expensive one and most uneconomical, and the difference of cost between such articles and others produced and manufactured on the same spot, has to be deducted from the wages of both producer and manufacturer, and from this follows the misery it entails upon the countries of both.

Nothing is more probable than that the railroads projected in Europe and in this country, before the outbreak of the war, will now be executed in proportion as money becomes more easy, and an increased demand for railroad iron will be the consequence. These facts prove that the moment to stimulate our home production of that article is a most promising and favorable one. The manner in which this object may be accomplished, and the industrial and financial independence of the country be established, we have indicated in general outlines. It is for our legislators to prolong the temporary pressure under which Great Britain recently labored, until our industry shall have gained strength enough to support itself, or else we shall remain what we are—a mere raw material producing country, at the mercy of every political, financial and commercial crisis of Europe.

Among the various branches of industry which, in consequence of the restoration of peace, will receive a new impetus, the manufacture of railroad iron occupies a prominent place. Before the war broke out, France, under the judicious management of her new government, had projected a great number of main and branch roads to complete a system of internal communication, of which, at present, not more than one-third is in operation. In Prussia, and the northern and central States of Germany, the proportion of necessary and projected roads to those already completed is nearly the same as in France, while in Southern Germany and the Austrian dominions these works can only be regarded as being in the first stage of their development. Spain and Italy, from national prejudice fostered by incompetent rulers, long opposed to these innovations of the age, have at last determined to follow in the wake of the leading nations of Europe. They have made their first efforts in the construction of railroads, and so has even Egypt; and European Turkey will have to imitate the example. In Russia only two main lines as yet exist; one from St. Petersburg to Poland, and the Austrian frontier; the other from St. Petersburg by way of Moscow to Odessa, of which latter the southern terminus is approaching its completion. These lines, however, are only intended to form the principal arteries, whence a great number of branch roads are to run to the different provinces of the vast empire. The exigencies of industry and commerce long since required their construction, and now that the experience of the late war has shown the military importance of a complete system of railroads, no sacrifice will be spared to call it into existence as speedily as practicable. Advices from that quarter inform us that such is the intention of the government. Under these circumstances the demand for railroad iron upon Great Britain from Europe alone will be quite considerable; not too considerable, however, to prevent her from controlling the American market, especially

after the financial pressure occasioned by the war shall have ceased to exert its influence. Her establishments have hitherto proved capable of supplying both Europe and America. But the extensive improvements contemplated and partly commenced by British capitalists in India will augment the demand for iron for several years to come, sufficiently to protect our manufacturers against an inundation of our market by British importations. From recent debates in Parliament we learn that a railway to Delhi, 900 miles in length, has been sanctioned. of which fifty-six miles are already completed, and 590 miles contracted for, to be finished towards the end of 1856: that the great India Peninsula Railway (North-eastern extension) has also been authorized, contracted for and nearly completed; that the South-eastern extension, eighty-five miles in length, has been sanctioned to Tookah, and is partly under contract, that a line from Madras to the south-west is to be opened towards the end of the present year, and that the Scinde Railway has been sanctioned from the harbor of Curachee to the Indus, a distance of one hundred and ten miles. The company having charge of this latter road, it is also stated, are at present engaged in collecting the capital and completing the surveys. Besides those mentioned, another road from Barado to Surat, one hundred and sixty-three miles long, has been sanctioned. Thus about one thousand two hundred and sixty miles of railroad are either in process of construction, or soon to be contracted for. The total amount of iron required for a single track of this length, at the rate of ninety tons per mile, is 113,400 tons. This is nearly as much as the whole production of the American mills in 1855, which amounted to 135,300 tons. England is evidently trying to make the most of the East India empire. She seems bent upon exploring the interior of her immense Asiatic dominions systematically. The efforts which she is directing towards that end are prodigious, but for this very reason, it is not probable that they can long continue. In a few years, all the principal roads and the most important branch roads will be completed. The present moment seems, therefore, to be a favorable one for the extension of our manufacture of railroad iron. Emigration from England and the effect of the war upon the financial condition of that country have assisted, as we had recently occasion to show, the progress of our iron industry. In 1855, we succeeded in producing over one-half of our own consumption of rails. Still there is room for improvement. Double the number of works at present in operation in the United States would be required to enable us to furnish the whole supply, even if the demand should not increase. It is to be remarked, however, that the consumption of railroad iron in 1855 was below that of former years. It did not exceed 262,816 tons, while the total average annual consumption for five years previous to 1855, amounted to 328,726 tons, of which 100,000 only were manufactured in our own mills.

For the last five years, the average number of miles added annually to our railroad system amounted to 2,393. Should no increase take place beyond this number, 215,370 tons would be demanded annually for new roads, besides the amount required for repairs and renewal of the old tracks, which is estimated to be eight per cent. Our American rails have been declared superior to the imported article by experienced engineers. Their manufacture has been developed in the short space of ten years, but it must be remembered that favorable outward circumstances came to our assistance, and that the result is not entirely owing to our own efforts. The legislative support yielded to this branch of industry has not been adequate either to its requirements or its national importance. Nevertheless, if under the present auspicious combination of affairs abroad it should be let alone and is not interfered with by injudicious legislation, there is hope that our manufactures will succeed in relieving the country from its dependence upon foreign labor, in this particular, at least. The scheme of repealing the duty on railroad iron at a moment when, after years of toil and labor and sacrifices, the first favorable prospect of ultimate success offers, is too preposterous to deserve a serious consideration. Were it possible such a folly could be committed, it would totally ruin one of the lead-

ing branches of American industry; strike a heavy blow at our entire mining interests, and disturb in a great degree a vast variety of tributary pursuits. It might furnish our railroad companies an inferior article at a trifle less than the cost of production of the superior American article; but it would throw thirty thousand people out of employment to benefit the British manufacturers and their importing agents in New York.—*Philad. North American.*

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IMPROVED MODE OF IRON SMELTING.

The iron manufacture of Great Britain is, before all others, the most important and extensive; and every thing calculated essentially for its welfare and prosperity demands not only the attention of the iron-master, but the support of the country.

We have before us, says the London Journal, a circular, addressed by Mr. Mickle, of Willington, Durham, to the iron-masters, and consider it deserving of the early and serious consideration of the community, because it proposes to effect an improvement of primary magnitude, and its data are evidently given with scrupulous regard to scientific truth, and practical and commercial soundness and solidity.

The effect to the iron-master practically, we conceive, will be this—that he will obtain as much metal of superior character, at less charge for fuel, from one furnace, as he now can from three or four, and at no increase of cost in any shape, except labor. The present capital for an establishment, therefore, which admits a supply of three to four millions, will then, with the same facility, yield ten to sixteen. Moreover, the coal, in some parts of the iron district, becoming scarce and expensive, has at different periods caused oppression and care to the manufacturer, placing him at disadvantage to those of more favored districts, and sometimes rendering the partial closing of his furnaces necessary.

The development of the manufacture of the last few years makes this a still more important question, because some of the older of the southern coal districts are comparatively exhausted, while the demand is increasing; and the effect will be that, as is now the case with Staffordshire, fuel will have to be brought from a distance; and in times of depression, the iron-master unable to sell at prices which, profitable to others, are ruinous to him, will have to put out his furnaces, and ultimately the capital embarked be valueless.

To the shipbuilders, the railway companies, and the public generally, the invention proposes to give a supply of superior iron in abundance, and necessarily cheaper. The most valuable, because most extensive, deposit of stone belonging to the country may be termed as yet scarcely touched; it is that of the formation of the lias, which, unaccompanied by coal, runs, with some interruption, from Eston to Scarborough, through Lincoln, Rutland, Northampton, Oxford, Wilts, and Dorsetshire, to Portland. Where this immense bed of ironstone approaches the surface, and at a reasonable distance from coal, as, for instance, in the Cleveland Hills, it is stated that Mr. Mickle's invention will make the iron-master to produce, without admixture of the red hematite, superior pigs, at or under 25s. per ton; and his furnace yielding per week 400 tons or upwards, instead of 120. Those companies whose railways lie on the route of this ore would feel its general development sensibly beneficial.

In his circular, Mr. Mickle states that in the present mode of iron smelting there is an enormous proportion of the fuel altogether wasted; and to prevent this waste, he proposes in his patent, in the first place, to divide the coal by dry distillation, and then use the gas and coke produced as fuel to smelt the ore. The coke may be charged as usual, while the gas is conveyed from the gasometer in pipes, and pumped into the furnace. The gas-pipe can either be *introduced into* the air-pipe near the furnace, or the gas itself forced through

separate pipes and tuyeres. The plan infers the use of a gigantic blowpipe; and those familiar with the oxy-hydrogen blowpipe will appreciate the power of the one proposed. Chemists of high standing, to whom the invention has been submitted, agree with the patentee, that the production of improved metal more cheaply and abundantly will follow its use. The intensity will render the heating of the air only desirable to increase an already extraordinary heat. Coal, on an average, contains of available hydrogen and carbon equal to 94 per cent. of coke: by the present methods, more than one-third of this is wasted; and it is shown that one ton of coal will go as far as one ton of the best coke, without any reference to the concentration of combustion and intensity of the blowpipe. Coal, as purified, is noticed as the purest of fuel. The intensity will more effectually separate the iron from the slag, and *vice versa*, and thus improve the quality. Mr. Mickle observes, that 3,000,000 tons of metal have been made during the year in Great Britain. This required 7,500,000 tons of coal; and of the latter, the best and commandable part, upwards of 1,000,000 tons, with 1,500,000 tons of coke, have been altogether rejected and dissipated.

The following estimate is given of its cost, when put in operation on an extensive scale. Suppose an establishment of four furnaces, yielding 450 tons of metal per week from clay ironstone, at 37 cwts. coke—832 tons 10 cwts. Retorts average 12 cwts. coal each in 24 hours × 7 — 84 per week. 832·5 tons coal divided by 4·2 — 210, add 10 allowed for repairs — 220 retorts:—

| | | |
|---|---|---|
| Retort, | $17.50 | |
| Flanged end and key, pipes, main, tar tank, coolers, purifiers, &c., | 27.50 | |
| Setting and furnace, | 15.00 | |
| 220 at | $60 | $13,200 |
| Shed, (120 feet × 20) | | 1,500 |
| Coal Box, Flat Sheets, &c., | | 2,000 |
| Gas holder, | | 2,500 |
| Mason work to hold do, | | 1,500 |
| Pipes, &c., from holder to furnace, | | 1,500 |
| Engine and Pumps, and Shed, | | 2,500 |
| Bridge, rails, &c., extra way, | | 250 |
| | | $24,950 |
| Less the cost of heating stoves, | | 8,500 |
| Total cost, | | $16,450 |
| Neither Shed nor holder is absolutely necessary, and their cost deducted, | | 5,500 |
| Leaves, | | $10,950 |

The furnaces will then produce 1000 tons of better metal weekly, according to size of hearth, and consequent proportion of gas.

The character of iron is based on two essentials—molecular constitution, depending on its electrical condition, and freedom from admixture with other substances. The importance of the latter, so dependent on the quantity of heat employed in reduction, is universally felt.

On the above estimate, an English engineer remarks:—

"You have shown that the cost of apparatus for producing gas for four furnaces is little more than the heating stoves at present used; but had you taken into account the saving in the cost of coke ovens necessary to produce 832½ tons of coke, the supply of four furnaces—which is about $25,000, as these would not be needed—this expense would be saved, making with the heating stoves a saving of from $45,000 to $50,000, against the cost of gas apparatus of $24,950, or a clear saving of nearly $25,000 on the first cost by the adoption of Mr. Mickle's patent, without taking into consideration the increased production and improved quality: the preference ought to be given to this mode of smelting iron. We may well admit the justice of the conclusion here, for the fire from the coke ovens light up the skies for many miles. From the data given, two leading coke firms, within my knowledge, must unavoidably be burning or wasting from 10,000 to 13,000 tons of coke and gas in a fortnight."

# JOURNAL OF GOLD MINING OPERATIONS.

## EXPERIENCE IN GOLD MINING.

RANDOLPH MINES, April, 1856.

STEPHEN P. LEEDS, ESQ.,

Dear Sir,—In responding to your call for information on the subject of gold mining, I had no idea that you would publish my letter. I try to clothe my thoughts in as plain language as I can command, without any pretensions as to style, etc.; any deficiency I beg to attribute to the fact that the English is not my mother tongue. You will therefore dispose of the following at your own pleasure,

Few, very few men, particularly among those who have been engaged in gold mining in this part of the country, entertain as favorable an opinion of the importance of this branch of mining as you do; most of them think mining generally, and gold mining particularly, a most precarious business. In inquiring for facts to sustain such an opinion, however, almost always something is found to be wrong: lack of judgment in the management of affairs (frequently termed, "bad luck"), want of capital to furnish the necessary equipments, or to make further developments, too much propensity for speculation either in not exploring while the mine is in a paying condition or in getting it into "market," will be found to be some of the most prominent causes for the "failure" of mines. Mining in this part of the country has been regarded too much as a fortune-making business (i. e., a business that makes a fortune in less than no time), and therefore has not received that attention, it so necessarily needs and so well deserves, and your remarks concerning management of mines are only too true. No superintendent ought to be without a journal of all the operations with all even apparently the most unimportant items; in the hands of a careful observer such a record is very apt to lead to a considerable decrease in expenditures, if it will not give results in the receipts. I am anxiously waiting for the statement of your results with your amalgamating apparatus. I have no doubt that the discharging through the centre of the arastre and bowl will give good results; ever since I have become acquainted with our gold mining machinery I have been of that opinion. The introduction of fresh clear water into the different machinery is the *conditio sine qua non* of a good amalgamating process. The fact that the occasional introduction of quicksilver into the Chilian mill increases the returns, was new to me, but I am now very well satisfied that this mill ought never to be used without quicksilver in the beds; in fact I am inclined to be of the opinion that mercury ought always to be used in the process of grinding gold ore.

Experiments with Berdan's Crusher, in which I have been engaged since my last, have considerably changed my opinion heretofore entertained of this crusher. I can now find no fault with it except such as arises evidently from bad workmanship. You will permit me to relate however. Let me remark at first, that the crushers, when they were tried here in 1854, were running at a speed of 25 to 28 revol.; I reduced it to 12 to 16 revol. per min. The first trial I made was on a lot of very hard ore (the term "ore" cannot properly be applied to it however, as the gold here is interspersed in a porphyritic rock, which contains very little sulphuret of iron, the richest hardly any), of 10 bushels. The highest yields heretofore obtained by the stamps from the same ore used to be from 19 to 21 cents per bushel, but this lot yielded to my *astonishment* $4.06 worth of gold (40.6 cents per bushel). To satisfy myself

then, that the difference was not in the ore, I raised 250 bushels of the same ore, and after reducing it to about 1 in. size, mixed it thoroughly. I then worked one part of it in the old way, which yielded 20.4 cents per bushel, whereas the Berdan Crusher yielded from the other part of the same lot of ore 41.3 per bushel. Such a yield was however not entirely unexpected, as judging from the show in the pan I always was of the opinion, that we did not save near all the gold heretofore. Several other trials gave about the same results. I have been using this crusher now steadily for nearly two months, and I have come to the conclusion that, if the necessary improvements are made, it is preferable to the Chilian mill for these reasons: *first*, it will, when properly used, turn out a better yield than the latter; *secondly*, its capacity for grinding is about three-fold; *thirdly*, it needs but little saving machinery, and consequently the cleaning out is done in less time; *fourthly*, it triturates to an impalpable slime with a great deal less power. You will bear in mind however, that *our* Berdan Crusher is only adapted to hard ore; if it can be made to answer for soft ore also, perhaps by reducing the weight of the ball (casting it hollow), this I do not know; I do know however, that our soft (decomposed) ore has to be very carefully treated, and some of it will even then not yield more than one half of what the Chilian mill did turn out of it.

The application of the following rules gave satisfactory results in triturating and amalgamating of our ore with Berdan's Crusher. The speed has to be not under 12 and not over 16 revol., the quantity of ore to be fed in not to exceed 4 bushels per hour (6½ lb. per minute); the quantity of water about 4 gall. per minute; the feeding has to be done regularly, and the ore reduced to pieces of uniform size of from ½ to 1 in. before feeding it into the crusher; the feeder has to prevent the ball from vibrating too much, which is done very easily by proper attention. In starting, the feeder has to keep on constantly feeding, until the stuff is carried around by the basin; after a bed of at least ¼ in. thickness (constantly going around) is thus formed, the quicksilver has to be thrown into the basin (not all at once however, but gradually during 5 or 10 minutes), 14 lb. of which may be sufficient, a larger quantity, say 20 or 25 lbs. being preferable. I forgot to remark, that I use in Berdan's Crusher water heated by the exhaust steam to over 100°. In using fire in the funnel the lower step is very apt to heat. The feeder must keep the bed in the basin of uniform thickness until ground down for cleaning out; not too thick, that every particle of gold may have a chance to come in contact with a globule of quicksilver, and not too thin, that there may be no chance for too great a division of the quicksilver (flouring it, grinding it away). (The reason why my experiments with soft ore have been unsuccessful was probably this, that it was impossible to keep a bed in the crusher, the quicksilver floating off in a floury state, as in cleaning out I found neither quicksilver nor gold, nothing but sands, which hardly paid for washing.) The grates in the spouts of the crusher have to be, of course, of a fineness corresponding with the sand to be produced; I use brass-wire gauze, about 1000 meshes to the square in. The loss of mercury out of the crusher amounts to from 2 to 3 lbs. per 100 bushels of ore, half of which is saved by a very imperfect rocker arrangement below, which with the quicksilver saves from 2 to 3 dwts. of amalgam, when the mercury in the crusher contains from 100 to 150 dwts.

This improved process has brought about an average yield of nearly 40 cents out of ore which heretofore averaged a fraction over 27 cents per bushel, hardly paying the working expenses.

In speaking of my rocker arrangement above I called it imperfect, as it is insufficient for the large body of water and sand; that two stirring bowls discharging in the centre and a stream of fresh water at this stage of the process would give far better results I do not doubt at all.

Concerning the rocker, I want to remark here, that some gold miners claim a rocker of an eliptical form to be superior to one of the circular form; what do you think of that? I am of the opinion that a rocker to work well ought

to carry a large circle; I also prefer a rocker with large riffles, say 12 in. wide and 48 or 4 in. apart, to such as you have been using; however, the opinions of experienced men differ considerably on that point.

With the above I expect to have given you too palpable an evidence of my wish that our correspondence may not cease; a personal acquaintance would afford me great satisfaction as in interchanging our views on the subject in question I should have no doubt the best end of the bargain.

I remain, meanwhile, very respectfully, yours, etc.,

J. PAGENSTECHER.

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QUERIES ON GOLD MINING.

RUTHERFORDTON, N. C., July 2, 1856.

W. J. TENNEY, ESQ.,

Dear Sir,—A gentleman in Nevada Co., Cal., has requested replies to a series of interrogations, among which are the following; perhaps the explanations asked by him may be interesting to others; thinking so, I reply to him through the pages of the "Mining Magazine:"

1. What is the power of steam engine required to work the crusher, with arastres, bowls and rockers?

We use one of 40 horse-power, and have spare power.

2. Of what material are the arastre bottoms, and are crevices cut therein? same of bowls?

The arastre bottoms are of a hard, compact, syenitic granite. There are four crevices cut in the bottom, of an elliptical shape, about one inch wide at the centre, and gradually narrowing at each extremity; they should be one inch deep at the deepest point, and the depth should diminish towards each extremity. They should be equi-distant from each other. They should extend to about two inches from the outer edge of the bottom, and to about the same distance from the step-block of the upright shaft.

The bottoms of the bowls should be made double, of one inch plank, with a perfectly plain surface.

3. Should the "Mining Magazine" not contain a working diagram of the arastres, bowls and rockers, with their gearing? how can the same be obtained, and at what charge, so that they could be made here.

The "Mining Magazine" will have sketches of the arastres and rockers, and sections of the bowls. We drive them from a long shaft by belt to counter-shaft; the counter-shaft having a 14 inch bevel gear running in a 36 inch. They should have 8 revolutions to the minute; to attain which, the size of the driving drums must be regulated by the speed of the engine, according to the known rules for such application.

4. Is the quartz ground in the crusher and arastres and passed through the bowls and rockers to be *very wet*? if not, of what consistency?

I have used a free flow of water, sufficient to float off the slimes from the crusher to the tanks; also enough water to pass the slimes through the arastres and bowls into other tanks; and a moderate flow to wash the sands over the rockers. *Mem.* The smallest possible quantity of water capable of effecting the movement of the slimes is all that should be used. *Loss will invariably accompany an excess.*

5. How much salt to each tank of twenty tons? About one peck.

6. What quantity of water is necessary to be thrown down in each tank through a perforated disk? must it cover the entire top, and what must be the size of the holes?

The disk should be 18 inches diameter; should be placed 8 or 10 feet *above the* tank; the holes be of the size of snipe shot; the disk be surrounded

by a rim 4 inches high; the water regulated so as not to overflow it, but to keep it about two-thirds full.

7. Is the greater portion of the amalgam collected in the arastres and bowls? How is the r cker used, and how many rockers to the arastre.

The most of the amalgam is in the arastre. The rockers have a swaying or rolling motion, of about two feet: the sands are placed by hand, in small quantities, about a gill at a time, and a small stream of water kept flowing upon it constantly; the stream of the size of a goose quill. Two rockers to each arastre.

8. What quantity of quicksilver is required for each bushel of "feed?" when is it put in? Is additional quicksilver to be put into the bowls?

The quantity of quicksilver is not by any means a settled point. I am trying this point now, and will be glad to receive information from others in this matter. The largest portion should be put in at first working, and the balance at intervals afterward. There should be quicksilver also in the bowls.

9. What sized aperture in the arastre and bowls for passing the sand and amalgam in "cleaning up," and how often cleaned up?

One inch diameter. The "cleaning up" must depend upon the richness and quantity of ore. Usually twice a week will suffice. Daily, if the ore is of very rich character.

10. The application of "flexible hose," and its size?

I cut off the usual supply of water, and pass enough through a one inch leather hose to freely wash out all the sands and amalgam. I use the hose because I can turn the water with it upon any and all parts of the arastre and bowls.

11. How is the trip hammer arranged? its size? Is it merely to *mark time?*

It is simply a small hammer arranged to strike upon an iron pan, to *mark time.*

12. What is meant by "each step of the operations," also, the *upper* portion of the *outer* rim of the arastre?

The sands pass from the crusher to the tanks. They are fed by hand into the arastre; fresh clean water is here introduced.. The sands then pass from the arastre to the bowls and into tanks. They are again fed by hand into the rocker, and fresh clean water again used. These are "each step in the operations." Simply the upper edge of the wooden rim.

13. Must the "two bushels of feed" be entirely passed through the arastre and bowls *during the hour*, and before further feeding be put in?

I "feed" continually at the rate of two bushels per hour.

14. Does Mr. Leeds recommend roasting either the quartz before crushing, or the tailings before being fed into the arastres? if so, what is the best mode of roasting; say by a wood fire or in a chemical furnace of a *large surface?*

Roasting ought *never* to be applied to gold ores. The Russian Government have fully proved to the world, by their experiments upon the ores at their mines, the fallacy of roasting ores.

15. Will not hot water be preferable for amalgamation?

Quicksilver in any temperature above 80° F. will readily attack gold, and below that point with a decreasing avidity in accordance with the falling of the temperature. This fact has probably given rise to the popular theory that a high temperature will facilitate its action. If any expense has to be incurred in sustaining a high temperature in the water, I would not use hot water, for the difference, if any, in the result, would not justify any outlay.

16. Several of our mills have 10 and 12 feet diameter of arastres, with stone bottoms, wood rims, with and many without crevices, 12 inches high of rim. Can these be made to answer Mr. Leeds' system? Is the six feet diameter of arastre preferable? if so, why?

I should use the arastres above described, cutting crevices in those which

have them not, and do not know that the 6 feet diameter are preferable to the others.

Having answered the questions, I would make the following extracts from other portions of the letter.

"In California 500 lbs. of cracked rock, the size of a cherry, is *at once* put into an arastre, and ground six hours before the 'tailings' are '*dipped* off;' about one hour previous 1¼ oz. of quicksilver is put in, say if the ore be worth $60 to the ton; 15 minutes before 'dipping off' from 12 to 20 buckets of water are rapidly thrown into the arastre. In most of the mills, the tailings or rock, *from the stamps* after passing over blankets, is conducted into the arastre *very wet*, which the writer does not approve of; he with *one* other party only, considering that the feeding should be put in *dry*, and occasionally water being merely sprinkled to wet the pulverized quartz."

"I will not apologize for taxing your friendly offices in this matter, it being one of general importance to our mining public, as also to commercial men. We are satisfied that not one dollar out of five is extracted from our quartz when the gold is fine, by the rude and inefficient process of 'stamps.'

"I lately saw at Sir Henry Huntley's mill, "Ball's Amalgamator," made in N. Y., which Sir Henry pronounced as superior to any thing he had yet seen. What is Mr. Leeds' opinion of these amalgamators? What is their price according to size, &c.?" As I have never seen one of Ball's Amalgamators at work I cannot, of course, advance an opinion upon their merits. Perhaps, friend Tenny, you can obtain the prices and give a list of them.

In conclusion, I hope to often receive similar epistles from mining men; I cannot give much information to my co-workers, but at any and all times, I will, upon application, cheerfully contribute my mite, in the hope that it may, at least, be of some little good to the mining cause.

Yours truly,

STEPHEN P. LEEDS.

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### STETSON'S SELF-OPERATING AMALGAMATOR.

We have in previous numbers alluded to an amalgamator, constructed upon principles entirely distinct from any of the methods now in use. It is known as "STETSON'S SELF-OPERATING AMALGAMATOR." This amalgamator consists of a series of drawers with circular openings half an inch in diameter, with a flange about half an inch high around each opening, so that the floor of the drawer between the openings can be covered about a quarter of an inch deep with quicksilver. All but the lower drawer are thus charged, and the openings so constructed that those of each drawer break joints with its fellow next below. The drawers being thus arranged and charged, the sand from the batteries is made to pass through a screen, first into the upper drawer, then through that next below, and then the next, and so on, until it has passed through the entire series. The multiplication of drawers may be carried to any desirable extent. They *should* be added *until no gold is found in the lower one.* Our own impression is that when the sand has passed a sufficient number of these drawers, *all the gold that is liberated from the quartz will be secured.* The water and sand, by this process, is made to fall from one drawer to the other, by an infinite number of small streamlets, divided almost into drops. By this *falling* of the particles of gold and quicksilver which may have escaped from the machinery above, an additional impetus is given to the specific gravity of the metal, which thus the more readily finds its *way into the body* of the quicksilver, upon which it is made to fall. The constant dropping of water also from the box above, subjects all the sand to a series of shower baths, which operation has long been known to afford a very considerable aid in the process of amalgamation. This amalgamator has been very extensively adopted in this neighborhood, and also in other portions of the State. We would not say aught to the disparagement of any other invention, but it is our opinion, *founded* upon close observation and some considerable experience in the

use of many other modes of saving gold, that this amalgamator is decidedly preferable to any now in use. It is universally acknowledged by all practical men with whom we have conversed, that the principle by which it brings the sand in contact with the quicksilver is the correct one. The machine requires but little attention, is more easily "cleaned up" than any other in use, and is not liable to get out of order. We cannot but look upon it as an invention calculated to have a very important bearing upon the most difficult and delicate process in the extraction of gold from its ores.—*California Mining Journal.*

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QUARTZ MINING AS A BUSINESS—WILL IT PAY?

The question as to whether this branch of mining with the present rate of labor and value of money, presents an opening for the safe investment of capital, with reasonable security for a profitable return, is often asked, but seldom answered satisfactorily in the affirmative, or the development of the business would have been more rapid, and those now engaged therein would experience less difficulty in obtaining occasionally a temporary loan to enable them to overcome some unforeseen obstacle.

Quartz mining away from the field of operation, is still looked upon with suspicion, with distrust. Why? for the simple reason that a lapse of three or four years has proved insufficient to dispel the impression created by the disappointment and losses sustained in '51–2. Calculations of 1851, based upon an assay of a few ounces of ore, were of the most extravagant kind, but the more extravagant the more acceptable to the then excited state of the public mind; no matter how large the capital called for, it was to be had. Men undertook the management of the business with no other qualification than a few hours' study of Ure's Dictionary, from which they only learned that the principles, as laid down in that work, and based upon the experience and practice of ages in other countries, were too slow and uncertain for this enlightened age. The experiments were as numerous as the failures. Money was squandered, and time, which then *was time*, was lost, and as might have been anticipated, failure ensued. But now reason has returned, the repudiated stamps and arastres have been restored, the business has assumed a legitimate shape, and henceforward is to be one of progress, to be more certain and profitable, as labor is further reduced, which will ensue when employment is constant and payment prompt.

But little capital has been brought to bear on the business during the last four years. Yet, notwithstanding the fact that many of the Companies now in operation, were among the first formed, and have, without money and without credit, struggled on for years and surmounted difficulties which in any other business would have overwhelmed them; notwithstanding they have consigned their experimental machinery to the foundery, and have replaced it with that which they know to be efficient, and are now getting out of debt; still, notwithstanding all these facts, we believe it would be more difficult now to raise a capital of fifty thousand dollars, than it was in 1851 to raise one of a million. Yet we predict that the day is not distant when we will count ten mills where we now count one.

It is not our design to pronounce quartz mining to be under all circumstances a safe or money making business; were it, it would be an exception to any other business, mining in particular, in the world. Our object is to show that the causes which led to failure years ago, have in a great measure been removed, and those most familiar with the business—men who have passed through the ordeal—are well satisfied that quartz mining will in a few years be the staple business of California.

In proof—some of our Grass Valley men are now putting up a mill with a powerful engine and 24 stamps on the Pennsylvania lead, eight miles above Iowa Hill, to replace a small one erected by them last spring, as a "Prospecting Mill." The new mill will cost less than twenty-five thousand dollars, and

have a capacity to reduce forty tons of ore each twenty-four hours. The ore will cost delivered on the platform from $1.50 to $2.50 a ton. This low estimate is based on the fact that the ledge is thick, easy to work, and contiguous to the mill, and should it continue to yield, what it now does, $15 a ton, the proprietors will be well satisfied.

The famous National lead near Eureka, is now in the hands of some of our Grass Valley men, who have erected thereon a mill to be run by water power, with five large stamps capable of crushing seventy tons of ore per week; the rock will cost delivered on the platform from $1.50 to $3 per ton, from preliminary tests, not of ounces but tons. This mine promises to be a very profitable one.

A company of five practical working men, miners and mechanics, from Grass Valley, recently erected a mill in Brown's Valley, with steam power, and having some six stamps, which cost about $8,000. They are said to be doing ery well.

The North Carolina Company, near Rough and Ready, are erecting a large mill with 24 stamps, having power to reduce some forty tons of ore each twenty-four hours. This mill is nearly finished, and will be in operation in a few days.

The Gold Hill Mill which was built when labor and material were very high, and cost more than double what it would now require to build a mill of equal capacity, has twenty-one powerful stamps, and at present works mostly upon custom work; can reduce some 300 tons a week, which at $6 a ton, amounts to $1,800. The cost of running this mill at the present time does not exceed $500 a week. Could such a mill be kept constantly supplied with ore, working merely as a custom mill, it would return the cost of construction with interest within a year.

The yield of ore reduced at the Gold Hill Mill, from twenty different localities, varied from $8 to $364 a ton, the average being fully $25 a ton.

Difference in expense of running a mill of say 24 stamps for 24 hours in the years 1853 and '56:

| | 1853. | 1856. |
|---|---|---|
| 1 Foreman, | 7 | 5 |
| 2 Engineers, | 16 | 10 |
| 4 Feeders, | 18 | 12 |
| 2 Men on platform, | 9 | 6 |
| 2 Amalgamators, | 12 | 9 |
| 1 Carpenter, | 7 | 5 |
| 5 cords wood, | 25 | 20 |
| Oil, &c., | 3 | 3 |
| | $97 | $70 |

No allowance is made in either case for management, nor for wear and tear of machinery.

Drifters in 1853 obtained $7 per day; ordinary laborers, $5. The former may now be had for four and the latter for three dollars a day. All know that labor commanded higher wages in the years '51-2, than in 1853.

The present cost per ton to raise the ore will depend upon the thickness of ledge, facility to work, &c., from $1.50 to $12; the cost of hauling from 75 cts. to $1 per ton, per mile.

*Present most approved mode of reduction.*

There seems at the present time to be a pretty general inclination on all sides to settle down upon the old-fashioned stamping mill, as decidedly the most economical and efficient mode of reducing the quartz, at least to a moderate degree of fineness. Experience, however, has fully satisfied the majority of miners that, in order to effect any thing like a thorough separation of the gold from its matrix, the ore must necessarily be reduced to a much greater degree of fineness than that in which it is left by the stamps. This must be accomplished by a subsequent and an entirely different mode of reduction. To accomplish this end many experiments have been tried, with varied success. Heavy rollers, Chili mills, with various modified forms of construction,

the *ball* process, "with little balls chasing big ones," and different grinding processes, have each in turn been adopted and discarded. There seems, at the present time, to be a very general inclination to get back to the first method of reduction, with arastres. Many companies now use them altogether, and a very great number who are using stamps are adding arastres, for the purpose of still further reducing the ores. We have not at our present command any definite results from arastres as used after stamps, but should be pleased to hear from any who may have made careful experiments with this mode of secondary reduction.

*Experiment in North Carolina.*

A very important experiment, on a large scale, is now being tried with the "tailings," from the famous Gold Hill Mine, in North Carolina. These "tailings," we understand, have been purchased by a company, which is known as the "Sand Co." They have erected extensive reduction works on the creek, about half a mile below the "Gold Hill" Company's mill. We hope to be in receipt of some information of the results of the "Sand Co.'s" operations at an early day. The company is very sanguine of success.

*Amalgamating Machinery.*

The methods of amalgamation adopted at different mills is more varied than that of reduction. One prefers hot water, another cold; one asserts that the gold can be collected entirely without the use of quicksilver, another insists that the thing is impossible; riffles of almost every variety of description are in use by different parties; some depend mainly on blankets, others discard them altogether. The number of the various "amalgamating machines" which are now, or have been used, is "legion." There are scarcely any two mills in the State that use precisely the same means for saving the gold. These facts go to prove that the best method of catching the gold is as yet very imperfectly understood, and still on the correct solution of this problem, more than on any thing else, depends the future prosperity of the mining interest.

It is universally admitted that we are now losing a large amount of the gold that is actually separated from the quartz. It is carried away partly in the quicksilver, more or less of which escapes from every machine which now is, or ever has been in use, and partly without having formed any amalgam whatever with the quicksilver. Much is doubtless lost in an inconceivably fine condition, so fine that its specific gravity can have little effect in checking its progress while in connection with a stream of running water.

There is but little difficulty in saving the coarse gold by any of the more approved methods now in use. It is the fine gold chiefly that escapes. We apprehend that the principles involved in most of the "amalgamators" now in use, and in every description of the "riffle" where the water is used, simply to *pass over* the quicksilver, or to fall upon it in a body and then pass off, or indeed to pass *through* a body of quicksilver on the principle of hydrostatic pressure, are not such as to ensure the greatest certainty in the separation of fine gold from the sand and water.

*General Summary.*

*Sierra County—New Mill.*—A party were in town last week, from Pike City, Sierra County, about sixteen miles from Nevada, for the purpose of making arrangements for the immediate erection of machinery upon a vein which they have been working for some time past. They have realized as high as $30 and $50 per day and upwards, from crushing selected rock in a hand mortar. We should be pleased to hear from these parties, and place their company in our "Mill Directory."

*Nevada County.*—The mills in this county are generally doing well. Several which have for a long time stood idle, have again been started, under auspices which bid fair for permanence. Among them we may mention the Wyoming, Canada Hill, and the Illinois Co.'s at Nevada. The Mt. George mill of this place, will soon be again in operation. The work upon the new mill at

Allison's ranch is fast approaching completion. We understand that still another mill is projected in this town, the particulars and location of which we have not yet learned. Two members of the Company alluded to in the last "Mining Journal," as at work near Jefferson, were in town a short time since making arrangements for the speedy construction of the mill. They contemplate putting up "rollers," constructed on a principle entirely new, the invention of Mr. Poole, one of the proprietors. It is an experiment which, if it succeeds, will introduce a great economy in the cost of reducing the ores. It is our purpose to visit and make a full report of the working of this machine as soon as it gets well into operation.

Several other valuable leads have been opened in the vicinity of this company's works. Among these we may mention one owned by Mr. Sweet, of this town, upon which he contemplates the early erection of a mill, to be driven by a 35 horse steam engine. This vein has been opened at intervals for the distance of 1200 feet, by shafts varying from fifteen to sixty-five feet in depth. The ore is very promising, abundant, and can be economically quarried.

The Rocky Bar Company, in this place, is now in a very flourishing condition under the new management of Mr. Brenan. Their rock is paying better than ever before, and appears to be richer as they descend.

*Placer County.*—We learn that the Pennsylvania Mill recently started in Humbug Cañon, is fully realizing the expectations of its proprietors. This is one of the largest mills in the State, and is owned chiefly by Judge Walsh and Dr. McMurtrie, of this place.

*El Dorado County.*—The Placerville American says that an extensive vein has been struck about a mile west of Spanish Flat, which prospects very rich. A portion of this vein is known as the "Daggett Claim." A shaft has been sunk to the depth of eighty feet, at which point the quartz yields from $60 to $80 per ton. The same paper alludes to another valuable discovery on the north side of the Big Cañon, near Placerville, by T. A. Gillerwaters & C. M. King. The attention of capitalists is called to the discovery as a very desirable place of investment.

*Amador County.*—The Jackson Sentinel says:—The mill of Messrs. Huffaker & Co. is now in full operation, and is doing a heavy business, considering the time occupied in crushing. It averages sixty pounds of gold per week, and only runs eight hours per day, owing to the scarcity of water. The same paper of the 3d ult., chronicles the discovery of a new lead, which prospects exceedingly well, and states that the parties are taking measures to build a mill upon it, which will be in operation in the course of a very few weeks. We learn that the mills generally in this county are doing remarkably well.

*Calaveras County.*—The Volcano Ledger says that the quartz mills are running night and day at that place, and that the deeper the shafts extend, the richer the quartz becomes. A vein of good promise is now being opened at Pine Grove, two or three miles from Volcano, upon which, should the present favorable indications continue, a mill will be immediately erected. A new vein has been discovered on the Mokelumne, from which the proprietor is realizing $10 per day with a hand mortar.

*Mariposa County.*—We have nothing new from this County except the following which we clip from the Gazette:—"On the upper Merced is a quartz mill, one of the best in the State. It runs ten stamps, each weighing over eight hundred pounds, propelled by a water-wheel 45 feet in diameter. Its capacity for crushing, with a fair head of water, is 20 tons per 24 hours. The mill requires but little attention, but pounds on night and day, to the great profit of its owners. Mr. Morris informs us that quartz yielding but six dollars to the ton, would pay fairly."—*Telegraph.*

# JOURNAL OF COPPER MINING OPERATIONS.

## COPPER IN VIRGINIA.

HILLSVILLE, CARROLL COUNTY, VIRGINIA, April 28, 1856.

*Editor of Mining Magazine,*

DEAR SIR:—Being a subscriber to your valuable Mining Magazine, I send you a few particulars respecting our large and rich field of copper in this county. It is true, the explorations and developments are yet in their incipient state; nevertheless in a few months last year the mines were opened, and in the short space of five months 2,000,000 pounds of copper ore were shipped, yielding from 25 to 40 per cent. I am informed by the different companies that the veins are very fine, and if the yield continues the same the balance of the year, that there will be sent to market 15 to 20,000,000 of pounds. The ores of these mines are exceedingly rich. Those already shipped have averaged from 25 to 30 per cent. while the Ducktoan ores are only 16 to 18 per cent. and the ores of England some 6 per cent. The great main Lead, as it is called, traverses the county for 15 miles; the vein of ore at every place that it has been opened is from 10 to 50 feet wide, and with proper management I verily believe that 50,000,000 lbs. of copper ore could be raised in one single year. The yellow sulphuret has been struck at a depth of 50 feet on two localities in this county, yielding from 4 to 20 per cent. When all the circumstances connected with these mines are taken into view, the great regularity of the lode and softness of the rock, the great width of the veins and facility for working them, and also the immense yield of copper ore taken out of the very limited space of a few hundred feet, and the convincing certainty of extensive deposits of yellow sulphurets, present inducements for mining adventurers, much beyond most if not all such localities hitherto worked in the United States.

Below you will find a table of analysis from ores of the Cranberry mine and Ann Phipp mine, which was made by Dr. Dickenson, of Philadelphia, and some samples of ore taken by myself from the Kirklride mine, which lies immediately southwest of the Ann Phipps mine on the main Lead. The ores have been taken as they occur in the lode. The results thus obtained when compared with the European ores, cannot but be highly satisfactory to those who hold such valuable property.

| | | | | | |
|---|---|---|---|---|---|
| Cranberry Mine, | Copper Ore, | Per Centage. | Ann Phipps Mine, | Copper Ore, | Per Centage. |
| " | Red oxide, | 61·05 | " | No. 1 poor, | 7·28 |
| " | Black " | 52·10 | " | " 2 " | 5·00 |
| " | Smut, | 26·00 | " | " 3 " | 4·00 |
| " | No. 1 poor, | 9·50 | Kirklride Mine, | Red Oxide, | 64·00 |
| " | " 2 " | 5·00 | " | Black Oxide, | 52·50 |
| " | " 3 " | 3·00 | " | Smelt, | 25·60 |
| Ann Phipps Mine, | Red oxide, | 66.08 | " | No. 1 poor, | 1·00 |
| " | Black " | 54·20 | " | " 2 " | 3·50 |
| " | Smut, | 24·08 | | | |

So you see at once that this region is bound to be one of the richest in the United States.

E. P. C.

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## LAKE SUPERIOR REGION.

*The Minnesota Bluff.*—In this hill three very valuable mines are now opened, theNational, Minnesota and Rockland. It forms the most prominent feature in the vein looking to the north of east from the Forest mine, from whence

many of the works of the two former mines are plainly seen. The bluff rises rapidly from the valley of the Ontonagon, to the height of five or six hundred feet, making a vertical distance of about one in three horizontal. As it goes easterly its course changes more into the south, being at the Minnesota some 10° more southerly than at the National. As its veins are characterized by great regularity, and are probably the richest in pure metal of any yet discovered, their mode of occurrence, and the positions of the formations containing them, become matters of great speculative and economical interest.—The late openings in these mines have served to add materially to our knowledge of their true character. It is now conclusively proved that the south lode, of which the National lode is the western outcrop, is the great master vein of this bluff, the Minnesota vein proper being only a sort of feeder or branch vein.

The bluff extends through a great part of section 15 and 16, for a distance of more than two miles, its course varying from 54° to 64° to the east of north. The Peninsula Bluff, a parallel hill of great regularity of form, and about equal height, with its southern side precipitous, lies to the south of it. The Minnesota Bluff at the works of the mine is connected on the north with another hill which branches from it and then seems to run parallel for a considerable distance. From this point of intersection there lie the three smaller ridges of much regularity and symmetry of form. Only a single *fault* of any considerable magnitude, is observable at the surface. This occurs to the east of the Minnesota mine, and is to be seen in all three of the bluffs, crossing them somewhat diagonally. A difference of level, of some thirty or forty feet is made in the middle bluff by this fault, the highest point being east. The northern and southern hills are only somewhat *gullied*, but the chasm made through all is quite perceptible.

This fault is the only surface evidence of *disturbance after the original upheaval of the formation.*

To the east of these hills the range is broken down by the gap through which the Flintsteel river passes almost on a level with the surrounding country, and beyond it disturbance and irregularity seem to prevail. Knobs and angular spurs are frequent, showing that the hills have been much heaved and disturbed since their original formation. And the copper found in them occurs in irregular beds and deposits which have not the character of true veins.

The National mine is opened principally by adits driven into the western end or termination of the Minnesota Bluff. The vein lies between a belt of conglomerate and the overlying trap of which the hill is principally formed. It is remarkably well defined, and has fine selvages. Its dip at the western extremity is about 56½° from the horizontal, and steadily diminishes until at the Minnesota mine it is only 46°, thus forming a sort of *mould board wall*, which becomes more flat as it goes east. The Rockland are now cross-cutting to get that vein, and will probably reach it soon. It is reasonable to suppose that when found, it will lie much more flat than at the Minnesota.

The north vein of the Minnesota, falls into the conglomerate or south lode at shaft No. 4, at the 30 fathom level, forming a vein of great strength. The point of its junction descends, however, as you go east, so that at No. 1, some 550 feet at the east of No. 4, it first runs into it near the 60 fathom level.—This would seem to indicate that the two veins come together on the surface at no great distance to the west of the Minnesota grounds, though the cross cuttings between the lodes would scarcely justify this conclusion. Yet a cross-cutting at the National mine, made for the purpose of intersecting the Minnesota lode, was driven without result for 180 feet.

As a rule, the power of the lode increases below the junction of the two veins; and the dip of the conglomerate vein is not affected by that junction.

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PORTAGE LAKE DISTRICT.

During the past eighteen months the editor has made several visits to, and has spent considerable time at Portage lake, giving to the mining matter

there careful attention, and has always been impressed by the apparent advantages possessed by that locality, for economical mining, over the other copper districts of the Upper Peninsula. The narrow lake from which the district takes its name, offers unequalled advantages for the transportation of freight to and from the main lake, with only a single rehandling for shipment or discharge there; it gives also a long coast line, with abundant lumbering and timber-making facilities; the Sturgeon and other streams pass by a great amount of natural meadow from which the hay may be taken by water to the spot where it is used; and coal, brought from below, may be used as a fuel without any tax whatever for its transportation by land. These are some of the commercial advantages afforded by the peculiar location of this district, and though they do not seem to be understood by the holders of mining stocks below, yet they become items of very great importance in the practical operation of a mine. Of the advantages of mining proper in this locality we shall speak hereafter.

It always seemed clear to us, that with equal richness of ground, mining could be prosecuted there with greater profit than in the other districts.

In June last we went through the Isle Royale mine, and also examined with some care that singularly promising development on the Pewabic location, but at the time were hardly able to form an opinion as to the value of the copper rock there. But the operations of the past eight or nine months have disclosed new features and proved up the ground so as to invest the district with a new interest to us. Meanwhile two of the mines have suspended, which were evidently commenced and carried on without sufficient show. Four mines only are now at work—the Isle Royale, Huron, Portage, and Pewabic. One of these, the Huron, has done but little mine work—having merely sunk four shafts to the first level and drifted a short distance from each of them and sunk the fifth a short distance. The other three are evidently working to a considerable profit over their expenses. The Isle Royale is most evidently effectually proving the value of the ground south of the lake, and as the Huron and Portage have the same vein, a description of some of the operations of this mine will assist greatly in estimating the value of the other two locations.

The Isle Royale stands fourth in rank among the mines of the Peninsula, for the production of copper last year, having shipped at the close of navigation 244 tons and 29 pounds, which were smelted by the Revere Co. of Boston, and yielded about 68 per cent without the slag. This amount was taken from the mine by a force of about 40 miners, the whole number of men and boys employed being about 180. Their stamp mill is in excellent running order, and is one of the best on the lake. They have power and room for a greater number of heads than they are now using.

In hoisting machinery they are somewhat deficient.

Their surface improvements in general are sufficient to work a large force and to prepare for market a great amount of copper.

The lode upon which they are working has many characteristics in common with those found upon the Evergreen Bluff in our own district. It is irregular in thickness, without proper walls, lies between formations having a marked difference in character, the hanging rock being of a reddish color, very hard and compact, while the country of the foot wall is more gray, softer, and coarser grained. Frequently there are rich copper deposits without veinstone, but generally the best barrel-work lies upon the foot wall in chloritic epidote. But while the general course of the vein is quite true, it frequently spreads out to an enormous width, sometimes as great as 37 feet and it will probably average 10 feet. Now while the miner will never object to a "regular vein," yet it must not be overlooked that these irregular deposits and beds of mineral, if the ground is really rich in copper, often afford many advantages for mining, not to be found in the more regular lodes of ordinary width. And one of these advantages is shown in the amount of vein-matter which a small opening will expose. For example, take an ordinary

vein of 18 inches width, and it requires four fathoms of drifting or stoping to get out one cubic fathom of vein matter. But, as the size of the vein does not afford space enough for the miner to work in, he is compelled to increase the width of his opening by taking down the country for perhaps twice the width of the vein. Whereas, in the Isle Royale mine he not only works entirely within the lode, but actually exposes an average of more than one and a half cubic fathoms of veinstone for every fathom drifted. Hence to open an equal amount of ground in the Isle Royale mine would require only one sixth of the time and money which would be necessary in such a vein as we have spoken of. This great advantage has shown itself in a striking manner in the underground operations of the mine during the past year. When we visited the location ten months ago, there seemed to be ground for suspecting that an injurious and delusive system of mining had been adopted by stripping the lode of whatever copper was in sight, to the neglect of the proper openings upon which the prospective value of the mine must depend. But upon our late visit we saw a very much greater amount of good ground exposed than before, and the appearance of the mine was unquestionably much richer and in better condition. The openings represented upon a longitudinal section, would scarcely show this, but it is for the reason mentioned above. This fact which we have been trying to illustrate is destined to tell wonderfully upon the economical production of copper in various locations to which we shall have occasion hereafter to allude.

From June to December they took down 294 cubic fathom of veinstone (for their measurements on this mine are always in *cubic* fathoms), from which they got 143 tons of copper—making nearly 973 pounds to the cubic fathom of ground. It must not be understood that the entire mine affords this high percentage. They have pursued the judicious plan of taking down only such parts of the lode as appear to be rich enough to pay, and hence a great deal is left unbroken, though this is the average of all the lode actually taken down. This system saves much expense in timbering up the mine, as the great width of the vein would frequently make much trouble if it were not for the occasional support afforded by the standing vein.

The ground is pretty hard. Drifting costs $9.32cts., sinking $16.33, winzes $9.50 per fathom lineal, and stoping costs $23.10 per cubic fathom.

A considerable amount of silver appears in some of their stamp work, which is apparently worthy of attention. What the assay would determine as to its value we do not know, but its presence is observable on mere inspection.

By dint of persevering effort in mining we are slowly collecting facts which will disclose the laws controlling the occurrence of Copper in this region. On the Point, where the veins are extremely regular, well-defined and walled, and cross the range at nearly right angles, it is found that the copper courses dip to the north, with the formation. In the Ontonagon District, where the veins run with the formation, it is generally thought that they dip to the west. On the southern side of Portage Lake hardly sufficient facts are collected to establish the matter beyond doubt, but the indications at present seem to favor the hypothesis that the courses of copper dip to the north in that locality. The question is one of great interest in practical mining, both in working old and opening new mines. In many localities where the laws of deposit are well understood and fully recognised, we believe they will lead to an entire change in the system of opening the ground.

The rock pulverized at the stamp mill during the winter, had not been washed, but had been piled up to await the spring thaw. Only the headers had been taken into the account of the monthly production of copper. The stamps had also been stopped for a considerable time. Yet they had weighed off for December, January and February some 48 tons of copper. The February product exceeded 21 tons including only nine barrels of stamp work. The usual product of stamp work would make the product of that month about 30 tons.—Their force will be considerably augmented in the spring, so that they have a good show for making 300 tons of copper during the current year.

We regard the present condition of the Isle Royale as very prosperous. They are not working upon a Minnesota or Cliff vein, and the stockholders, in their venture, have drawn no such magnificent prize. But there appears to us to be a fair promise of speedy remuneration for the capital embarked in the enterprise.—*Lake Superior Miner.*

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CLIFF MINE.

The CLIFF are now working about 225 miners; and during the year ending March 1, 1855, have worked from 187 to 226. They have drifted during the same time 1,786 feet, at a cost of $8,50 per foot; and stoped 2,120 fathoms of ground at a cost of $20 per fathom. Their monthly product in that time has averaged 125 tons 1,241 pounds—the ground yielding the immense amount of more than 1,200 pounds of rough copper per fathom. Of this monthly average nearly 66 tons was mass copper, more than 31 was barrel, and more than 28 was stamp work. Of the stamp work about 15 tons were headers.

The present stamp mill is not very good, but they are putting up a new building to run an additional 24 head, and a fine washing house 50 by 100 feet in size. The now pulverize about 570 tons of rock per month. During the year ending March 1, they stamped 13,680,000 pounds of rock, yielding 169 pounds of copper—or 5¼ per cent. This would seem to show a rock of unparalleled richness in fine copper, but it should be borne in mind that they have never had machinery to work up their stuff close, and have probably thrown aside much that would pay well if they could have manufactured it. The day may come when the stulls and burrows of the Cliff location will afford in themselves a richly paying mine.

We may say, we hope without giving offence, that there has been a time when the gentlemen who controlled the Cliff mine were not fully aware of the immense value of the mineral ground included in their location. Apparently apprehensive of a failure to find copper at considerable depths, they have heretofore exercised an undue caution in their expenses; so much so that the permanent requirements of this vein have not been amply supplied, and immediate profit has absorbed too much of their care. This is not surprising, when we consider the infancy of mining in this region, and the fact that many neighboring enterprises, which were at the surface exceedingly promising, had given out as they went down. Could the actual condition of things below the surface have been seen four years ago, and had facilities for work been adapted to them, even the present magnificent product might have been greatly increased. Their underground force has been much limited, the lower levels occasionally flooded with water, the road-ways choked up, and all the mine workings embarrassed by want of adequate machinery and openings. The new engine and capstan will probably enable them to do all that can be done through the shaft now made; but to supply the want of openings requires the work of years.

A different and broader policy now prevails. Under the present energetic direction and superintendence every thing about the mine indicates *progress* and an enlightened but liberal economy in their plans. A new vertical shaft is being sunk in the bluff some 940 feet north of No. 3; a new engine and hoisting machinery has been set up for taking out their copper; explorations on the surface and by cross-cutting are going on; among the buildings to be erected this year are a new washing house 50 by 100 feet in size; 10 good dwelling houses, a fire proof store house, a powder magazine, a stone smith shop, a mineral house, a saw mill, a carpenter shop, and a changing house. The new road through the valley of Eagle River will be macadamised for a great part of the way. These improvments will make the valley of Clifton, which already contains 1,100 inhabitants, quite a pretty town. And they will certainly be important additions to the working facilities of the mine.

But the great improvement now in progress is the shaft sinking on the bluff. It has to be sunk below the greenstone, a distance of some 800 feet, be-

fore it reaches the vicinity of copper-bearing rock. It will be a vertical shaft, and is already down a considerable depth. This opening is absolutely essential to the development of the full capabilities of this monarch of mines. The useful effects of the new machinery and surface improvement will necessarily be limited to the capacity of the present shafts. And these, it cannot be denied, are miserable affairs—so irregular and ill constructed that they frequently cause great vexation, expense and delay by the breaking of machinery, &c. They have not holes enough in the ground at the Cliff mine to accommodate a full complement of men, even in their present openings, and the mine may be sunk and extended as long as men of the present generation wish to work it. The new shaft is commenced upon the true system, and when complete and supplied with proper machinery will have capacity for hoisting equal to all the others. Had this opening been commenced in time, and vigorously prosecuted, and adequate machinery supplied at the other shafts, the Cliff mine might have produced 3,000 tons of copper during the past year. It must still be very many months before this can be complete.

During the coming summer explorations will be made on the north of the bluff, and should the surface indications justify, they will probably commence openings still nearer to the lake.

A system of working the mine has been pursued at the Cliff which differs considerably from the ordinary plan. The amygdaloid copper-bearing floors dip to the north about 24° from the horizon. The ordinary regular horizontal openings seem to be partly disregarded, and only the lower levels of the mine are driven to the south in advance, and from these the stoping is carried back and upward on the inclination of these copper courses. As the vein is broken, it is thrown down through a mill to a lower level, and thence trammed out to the shaft. The stoping, therefore, does not seem to follow the ordinary levels or horizontal openings. The visitor after descending a few lifts by the ladder road, walks down the stull on a continual decline until he reaches the fifty fathom level—passing on his way some of the finest exhibitions of native metal to be met with on the globe—descending through tall galleries vaulted with the white, sparry crystals or projecting copper, and being frequently obstructed by craggy masses of the dull-brown metal and gray rock as high as a house. The copper in this mine does not occur in that beautiful and regular form which characterizes it in the North American or in the Minnesota and Rockland mines. On the contrary, the large masses are frequently extremely jagged and shapeless. But they are sometimes continuous for an incredible height and distance. In fact, some of them appear to have been connected by strings and branches almost from the top to the bottom of the mine.

Whether the mode of working to which we have alluded is only the result of some temporary convenience, we are not advised. But we have no hesitation in hazarding an opinion, based upon observation of the occurrence of copper in the mines on the Point, that, as the science of mining advances and assumes an definite *local* character in that district, the openings will be made more frequently to conform to the dips of the copper-bearing courses of rock.

In studying the character of the Cliff mine, it is but justice to acknowledge that we were greatly assisted by the use of a large plan recently made after a most careful survey, by Messrs. Hulbert & Lum, Civil and Mining Engineers of Eagle River. It is got up on a system which is new in this region, but which, we believe, in connection with the ordinary longitudinal section, will prove a most valuable aid to the practical miner as well as the geologist. It is a working plan of each level in the mine, with graphical representations of all the vertical openings in the floor of the level, as shafts, winzes, ladder roads, &c.—of all the different courses and belts of rock, slides, floors, &c.—and of all the branch veins, crosses and feeders which touch it. The ordinary longitudinal section can represent little else than the amount of openings, the dips of the rock, and the surface line. But a plan like that named gives the position of each of the intersecting veins, &c. And this will frequently make the most important suggestions to the intelligent miner. The execution of the work is

highly creditable to the professional talents of the gentlemen whom we have named.

There are several interesting features in the Cliff mine which are calculated to awaken speculation as to their real character. What is the East vein? It has been followed a little north of its junction with the main lode, but not to the south, though it is quite well defined there. It seems probable that it is a cross vein of a different age, and not a mere feeder or branch. The result of opening it south of the intersection cannot be predicted, but it would appear to be worth the examination, whenever they are able to take out any more copper than they now have in sight. Again, a few hundred feet south of the Sump shaft are two remarkable cross courses, observable in all the levels which are open to them. Though near to each other they have a different dip, so that one intersects the main vein north of the other in the upper levels, and south of it in the lower levels. One of them has been worked upon in several levels south of the point of intersection, and was found to contain very rich ground.

Now is there not ground to give plausibility to the conjecture that these "cross courses" may prove, on thorough exploration, to be other productive veins—in short, that the present openings in the Cliff mine are side by side with *three other veins* of unknown richness, which intersect each other and the main vein at a small angle. Time and examination only will decide this.

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## MISCELLANIES.

### TURBINE WATER WHEEL.

The opinion that "no more than fifty per cent. of the water power could be obtained from a wheel discharging its water in a contrary direction to the wheel's motion" was at one time current among hydraulic engineers. This notion operated prejudicially to improvements on the re-action water wheel; hence, for a great number of years after the breast and overshot wheels had become very perfect, the re-action wheel only existed in the form of the "Barker Mill," viz., a central tube, and two horizontal hollow arms on a vertical shaft, from the extremities of which the water was discharged, and gave motion to the shaft by a recoil. We believe that the world is much indebted to French hydraulic engineers for directing attention to old errors, and pointing out the advantages to be obtained from improved reaction wheels, to which they gave the name of *turbines*, because of the peculiar construction of their buckets, and the spiral form of the water shutes. It is generally believed in America, however (and from what we know of the subject, we think the belief is founded on correct data), that improved turbine water wheels were in use in the United States before they were employed in Europe; but be that as it may, the French hydraulic engineers deserve much praise for what they have done in improving them. We therefore expected to find quite a number of turbines on exhibition, but in this we were disappointed, for we only saw a double one, and all the novel features embraced in it were simply a vulcanized india-rubber shute, and draft boxes, stiffened with wooden plates. These were perfectly water and air tight, desirable qualities no doubt, but wooden flumes and draft boxes are much cheaper in America, and may be made to answer every purpose. Seventy-five per cent., we were given to understand, was the amount of power derived from the best constructed French turbines; this falls short of the results obtained by the turbines at Lowell, still it is equal to those obtained from the common breast and overshot wheels. We hope the reports of the performances of this class of wheels are correct, because they are much less expensive to construct than other kinds.—*Scientific Am.*

### IMPROVED LEVELLING INSTRUMENT.

A new levelling instrument, under the title of an inclinometer, was recently patented by Mr. Gillespie, of Edinburgh, and is now manufactured and supplied by Messrs. Young, Peddie & Co., of that city. This machine is now getting into extensive application, and proves to be an important instrument for measuring, finding, and adjusting the depth and outfall of drains, water courses, conduits, surface, slopes of land, embankments, roads, railway gradients, and in all levelling and sloping operations required in civil engineering. It consists of a rectangular parallelogram, or frame of mahogany or oak, strengthened at the angles with metal plates. On the top of this parallelogram is placed a hinged horizontal bar, mounted with a spirit level, depending from which bar is a vertical arm, properly graduated, and carrying a plumb line, in such manner that any slope whatever upon which the base is placed is represented on the graduated scale top. Every operation known in civil engineering may be performed by this instrument, and will much aid the geologist and scientific explorer in examining the dip or inclination of the different strata. Numerous testimonials have been received as to its being light, portable and elegant, and fully applicable to the purposes intended.

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### CONSTANT ACTION BLOWPIPE.

S. de Luca has proposed to attach a vulcanised india-rubber bag to the tubular stem of a common blowpipe, and to fasten the cylindrical end with its nozzle to the other end of the bag, the latter thus constituting a part of the stem of the blowpipe. The end of the tubular stem which opens into the bag is closed by a valve which opens inwards. If air be blown through such a blowpipe, the elastic bag will be inflated, and as the compressed air cannot return through the valve, it will flow through the nozzle, and maintain the blast of air constant, the bag requiring only to be filled from time to time. Such an instrument does away with the inconvenience of maintaining a constant blast by the mouth, which is very tiresome, and to many persons injurious, especially when it is necessary to blow for a considerable time. The form recommends itself as much to jewellers as to chemists.—*L'Institut.*

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### SIMPLE MODE OF CUTTING STONE.

Among the French machinery will be found a very ingenious and simple mode of cutting stone, exhibited by a man named Chevaliere. He causes a wire to run at a high velocity over the surface which he wishes to bisect, and by dropping on it a mixture of sand and water the operation is rapidly completed. The hardest granites yield so quickly to that process that the inventor can with one-horse power separate it at the rate of a square foot per hour, the wire running at the rate of 40 ft. per second. Using the ordinary saw, the same amount of work would require three-horse power, and would expend 15 frs. worth of material, instead of 1 fr., which is all that the wire costs.